ISSN:0015—3001

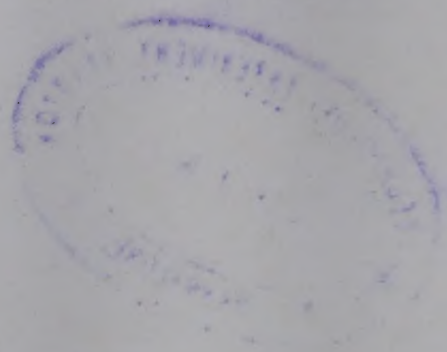
Fishery Technology

JANUARY, 1982

VOLUME 19, No. 1

TECHNOLOGY EXPERIMENT STATION
6/9/82
BANGALORE

Society of Fisheries Technologists (India)



Fishery Technology

FISH TECHNOLOGI EXPERIMENT STATION
C.F.T.R.I.
MANGALORE

January 1982 Volume 19, No. 1

EDITORIAL BOARD

Editor

N. Unnikrishnan Nair

Asst. Editor

P. A. Perigreen

Members

A. K. Kesavan Nair

K. N. Kartha

Cochin: Society of Fisheries Technologists (India)

Society of Fisheries Technologists (India)
Cochin-682 029

OFFICERS AND COMMITTEE, 1982

President

C. C. Panduranga Rao

Vice Presidents

M. R. Nair

N. G. Magar

Secretary

R. Balasubramanyan

Assistant Secretary

A. Vasanth Shenoy

Treasurer

G. R. Unnithan

Executive Committee

P. Appukutta Panicker

K. K. Balachandran

T. S. Gopalakrishna Iyer

K. Gopakumar

M. K. Kandoran

K. Radhalakshmi

K. Ravindran

M. Shahul Hammeed

P. Vasudeva Prabhu

Society of Fisheries Technologists (India) is established to promote the cause of fisheries in general and fisheries technology in particular in all its aspects by (a) providing a forum for fishery technologists connected with production and processing of fish, design and construction of fishing boats and gear and manufacture of engines, auxiliaries and deck equipments, to meet periodically for discussion, exchange of information, findings and experience on different aspects of fisheries technology, (b) encouraging original investigations on problems related to fisheries technology, (c) publishing a journal called **"Fishery Technology"**, (d) instituting prizes in recognition of out standing contributions to the advancement of fisheries technology in India and (e) such other means consistent with the aims of the society as the executive committee may decide.

Membership shall be open to all persons interested in fisheries, fisheries technology and fishing industry. Details of further facilities accorded to members and forms of application for membership are available from the Secretary, Society of Fisheries Technologists (India), Matsyapuri P. O., Cochin-682 029, INDIA.

Fishery Technology is published and distributed by the Society of Fisheries Technologists (India). It is published twice a year in January and July.

Single copy of each issue of the journal will be supplied free to the bonafide members of the society. For others, the rate of subscription for the journal is as follows:

Overseas	US	$ 12
Inland	Rs.	40

Terms are cash with order or against proforma invoice. Orders and subscriptions should be sent to **"Society of Fisheries Technologists (India)."**

Claims regarding issues lost or damaged in transit should be addressed to the Editor, Fishery Technology, Matsyapuri P. O., Cochin-682 029, India. Claims cannot be entertained if they are received later than three months after the date of posting plus such time as would be expected for transit by post.

Enquiries for back volumes of the journal should be addressed to the Editor, Fishery Technology, Matsyapuri P. O., Cochin-682 029, India.

The Indian Council of Agricultural Research, New Delhi has given a generous grant of Rs. 7,500/- for 1981–1982 towards the publication of Fishery Technology.

The society and the editorial board assume no responsibility for the statements and views expressed by contributors.

Contents of Volume 19, No. 1, 1982

PAGE

Water soluble nitrogenous component from squilla *(Orato squilla nepa)*

A. Lekshmy Nair & P. V. Prabhu 1

Report on the occurrence of one subspecies of *Scylla serrata* (Forskal) in Cochin backwaters

C. K. Radhakrishnan & C. T. Samuel 5

Survey on the idle capacity of fish processing (freezing) plants in India- II. East coast

H. Krishna Iyer, P. Srinivasa Rao, G. R. Unnithan, A. K. Kesavan Nair & R. G. Nair 9

Experimental trawling in Hirakud reservoir

V. C. George, Percy Dawson, A. A. Khan & M. D. Varghese 15

Biochemical changes of fish fingers held at frozen storage

P. Ravindranathan Nair, R. Thankamma & K. Gopakumar 19

Processing clam meat into pickles

P. K. Vijayan, P. A. Perigreen, P. K. Surendran & K. K. Balachandran 25

Studies on frozen storage of ghol *(Pseudosciaena diacanthus)*

D. K. Garg, Jose Stephen & A. P. Valsan 29

PAGE

Bacterial flora of EDTA treated oil sardine *(Sardinella longiceps)*, Indian mackerel *(Rastrelliger kanagurta)* and prawn *(Metapenaeus dobsoni)* in ice storage

P. K. Surendran & K. Gopakumar 33

Pickled products from green mussel

V. Muraleedharan K. George Joseph & K. Devadasan 41

Ice storage studies of kati *(Pellona* sp.)

D. K. Garg & Jose Stephen 45

Investigations on the number of trials required for statistical comparison of fishing gears

A. K. Kesavan Nair 49

Response of extract release volume to the variations in pH and microbial load during spoilage of fish at refrigeration temperature

V. N. Bachhil 55

Improving the acceptability of canned mackerel tuna *(Euthynnus affinis)*

K. K. Balachandran P. K. Vijayan & Jose Joseph 59

Letter to the Editor 61

INDEX TO AUTHORS

Bachhil V. N.	55	Nair, R. G.	9
Balachandran, K. K.	25,59	Percy Dawson	15
Devadasan, K.	41	Perigreen, P. A.	25
Garg, D. K.	29,45	Prabhu, P. V.	1
George, V. C.	15	Radhakrishnan, C. K.	5
George Joseph, K.	41	Ravindranathan Nair, P.	19
Gopakumar, K.	19,33	Samuel, C. T.	5
Jose Joseph	59	Srinivasa Rao, P.	9
Jose Stephen	29,45	Surendran, P. K.	25, 33
Kesavan Nair, A. K.	9,49	Thankamma, R.	19
Khan, A. A.	15	Unnithan, G. R.	9
Krishna Iyer, H.	9	Valsan, A. P.	29
Lekshmy Nair, A.	1	Varghese, M. D.	15
Muraleedharan, V.	41	Vijayan, P. K.	25, 59

The following papers appeared in the last issue of Fishery Technology

Contents of Volume 18, No. 2, 1981

	PAGE
Oxidation of residual lipids in fish protein concentrates and its effect on the nutritional quality of the protein K. Devadasan	71
Biology of fouling in Neendakara Port, a tropical estuary in the south west coast of India K. Dharmaraj & N. Balakrishnan Nair	79
The influence of plating technique and incubation temperature on the bacterial count from fish and fishery products Nirmala Thampuran, H. Krishna Iyer & K. Mahadeva Iyer	95
Seasonal changes in the biochemical composition of ovary in *Heteropneustes fossilis* (Bloch) Kalpana D. Shreni	101
Microbiological evaluation and keeping quality of fishes reared in livestock sewage fed ponds without artificial feed V. N. Bachhil	105
Survey on the idle capacity of fish processing (freezing) plants in India– I. West coast H. Krishna Iyer, P. Srinivasa Rao, G. R. Unnithan, A. K. Kesavan Nair & R. G. Nair	109
Studies on blue discolouration in canned body meat of crab *(Scylla serrata)* P. K. Vijayan & K. K. Balachandran	117
Influence of sex, spawning, starvation and water temperature on fatty acid composition in *Tilapia mossambica* K. G. Ramachandran Nair & K. Gopakumar	123
Comparative study of the nutrient content of fish and shell fish M. K. Mukundan, A. G. Radhakrishnan, M. A. James & M. R. Nair	129
Selection of bacterial flora in the chlortetracycline treated oil sardine *(Sardinella longiceps)*, Indian mackerel *(Rastrelliger kanagurta)* and prawn *(Metapenaeus dobsoni)* during ice storage P. K. Surendran & K. Gopakumar	133
On the vertical distribution of seers and other commercially important fishes in the surface drift nets Percy Dawson, J. Sitarama Rao & Y. Sreekrishna	143
Book review	145

INSTRUCTIONS TO AUTHORS

Papers submitted for publication in *Fishery Technology* should be typewritten, double space on one side of the paper only, in duplicate. The manuscript should be in the final form and no alterations or additions are allowed at the proof stage. Typescripts that are not concise or do not conform to the conventions of *Fishery Technology* will be returned to the author for revision. Papers should be sent to the Editor, Fishery Technology, Matsyapuri P. O., Cochin-682 029, India.

Contributions from authors who are members of the Society of Fisheries Technologists (India) and who do not owe dues of any sort to the Society alone will be considered for publication. Non-members who are desirous of publishing papers in *Fishery Technology* shall enroll themselves as members of the Society paying the prescribed subscription and admission fees.

Original research papers, short notes and review articles on fishery technology or any other branch of marine science will be accepted for publication.

Papers should be headed by a concise but informative full title, by the names of the authors (name in full with initials for each author) and the name and address of the establishment where the work was performed (foot notes, indicating present addresses may be included on the title page). Titles of papers should be sufficiently descriptive and informative about the contents so that the titles can be used in indexing and in coding for information, storage and retrieval. Authors should also give a shortened version of the titles not exceeding 60 letters and spaces suitable for a running title.

Papers are divided into the following sections:

(a) The *synopsis* should contain a brief but informative summary of the contents and conclusions of the paper and should also highlight any new information contained in the paper. Normally the synopsis should not exceed 250 words and should be in the form acceptable to abstracting journals; *(b) Introduction* should contain the purpose of the investigation and its relation to other works in the same field; *(c) Materials and Methods; (d) Results and Discussion.* The results may be presented in the text or in tables or in figures and should be described with a minimum of discussion. Both tables and figures illustrating the same results will not be permitted. Drawings or illustrations should be made in Indian ink on tracing paper, approximately twice the dimension of the finished product as it will appear in the journal (usually single column width); *(e) Acknowledgements; (f) References.* The Harvard system, not the numbering system should be used for the citation of references in the text, as follows: For paper written by one or two authors, as 'Finch (1956)' or '(Finch, 1956)' or 'Brewer & Stewer (1942)' or (Brewer & Stewer, 1942)'. For papers written by three or more authors as, 'Smith *et al.* (1957)' or (Smith *et al.*, 1957). Where more than one paper by the same authors, it should be given as 'Brewer & Stewer (1956 a, b)' or '(Brewer & Stewer, 1956 a, b)'. At the end of the paper, references should be listed in *alphabetical* order except for papers by three or more authors (which are given in the text only as *et al.)*, which should be grouped in chronological order after any other papers by the first author. The authors' initials should be included, but not the title of the paper. Examples:

Finch, G. I. (1956) *J. Sci. Ind. Res.* **15,** 539

Pope, C. G. & Stevens, M. F. (1939) *Biochem. J.* **33,** 1070

Kerbs, H. A., Speake, R. N. & Hems, R. (1965) *Biochem. J.* **94,** 712

Mavinkurve, S. S., Gangal, S. V., Savant, P. L. & Kumta, U. S. (1967) *J. Fd Sci.* **32,** 711

It should be noted that the year, volume number and first page should be cited for references.

Titles of journals should be abbreviated in accordance with World List of Scientific Periodicals, 4th edition and supplements.

References to books and monographs should include names of editors, edition number, volume number, relevant page numbers, name of publisher and town where published. Examples:

Benyami, M. (1959) in *Modern Fishing Gear of the World* (Kristjonsson, H., Ed.), Vol. 1, p. 213, Fishing News (Books) Ltd., London

Schultz, H. W. (1960) *Food Enzymes,* 1st edn., p. 65, The AVI Publishing Company Inc., U.S.A.

All units should be expressed in metric system. Figures in the text should be given Arabic numerals and their position appropriately marked in the text. All figures should have captions. Tables (as few as possible) should be typed on separate paper and should be given Arabic numerals and their position marked in the text. Each table should have a caption.

For every contribution the author will be supplied fifteen gratis reprints in the case of single author and ten reprints each in the case of joint authorship. Number of extra copies required (with or without cover) at cost price plus postage must be communicated to the Editor, on receipt of communication regarding acceptance of the paper for publication.

The number of words per article should be restricted to 3,000 for review articles, 2,000 for research papers and 1,000 for notes.

Fish. Technol. (1982) **19**, 1-3

Water Soluble Nitrogenous Component from Squilla *(Orato squilla nepa)**

A. LEKSHMY NAIR and P. V. PRABHU

Central Institute of Fisheries Technology, Cochin-682 029

A water soluble hygroscopic powder has been isolated from squilla in good yield, ranging from 3.5 to 5.0 per cent of the fresh raw material, by a simple direct method. The process consists of homogenising squilla with an equal quantity of water, removal of chitinous matter from the slurry by filtration, heating the filtrate at 0.7 kg/sq.cm steam pressure for 15–20 minutes, removal of the precipitated protein by filtration and concentration and final drying in vacuum of the filtered cooled liquor. The pale brown powder so obtained consists mainly of peptones and proteoses and has been found to be comparable to BDH peptone for growth of bacteria, ability to serve as source for tryptophan for indole production and to provide substrate for the production of hydrogen sulphide. Comparative studies have been made on similar water soluble fractions from two species of prawns, namely, *Metapenaeus affinis* and *Parapenaeopsis stylifera.*

Squilla *(Orato squilla nepa)* is available in plenty throughout the west coast of India and is caught along with prawn in trawl catches. Although exact data on the total landings of squilla is not available, it is present as a by-catch in sufficiently large quantity to warrant development of suitable methods for its utilisation. Since it does not contain appreciable amount of meat and great difficulty is encountered in separating the meat from the shell, the squilla available in India has not been put to any commercial use. Recently, attempts have been made for development of methods for better utilisation of squilla. Madhavan & Nair (1975) have described a method for preparation of chitosan from squilla. A simple method for the isolation of protein from squilla without any chemical treatment has been reported by Garg *et al.* (1977). During earlier studies on squilla, it was observed that a major portion of the nitrogen present in squilla came out in water soluble fraction during the precipitation and separation of squilla protein. The present paper reports the yield and composition of the water soluble nitrogenous fraction of squilla. A comparative evaluation has also been carried out between the water soluble nitrogenous components of squilla and two species of prawns, *Metapenaeus affinis* and *Parapenaeopsis stylifera.*

Materials and Methods

Squilla caught by the Central Institute of Fisheries Technology fishing boats from the sea off Cochin was washed, iced immediately and brought to the laboratory. It was stored in crushed ice and used the next day or was frozen and stored at –20°C until taken out for further processing. The prawns used in the experiments were purchased fresh from the local market and kept heavily iced for about a day before taking for experiments the next day. All the samples used were in organoleptically good condition.

Isolation of the chitinous matter and protein from the samples was done according to the method described earlier (Garg *et al.*, 1977). The water soluble portion obtained after separation of the precipitated protein was concentrated on a water bath and finally dried under vaccum (750 mm of Hg at 45–50° C). A pale brown hygroscopic powder was obtained. Decolourisation of the cooled filtrate with activated

* Paper presented at the symposium on "By-products from Food Industries–Utilization and Disposal" 29-30 May, 1980 at Central Food Technological Research Institute, Mysore.

charcoal was also attempted to improve the colour of the final product, with little success. Total nitrogen and chitin nitrogen of raw material were estimated by the method of Garg *et al.* (1977). Coagulable nitrogen, proteose nitrogen and peptone nitrogen present in the water soluble fraction were determined according to Winton & Winton (1958).

The samples prepared from squilla were incorporated into various bacteriological media, both liquid and solid and their growth promoting properties were studied using selected bacterial strains.

Results and Discussion

Results of a few typical trials on the isolation of water soluble nitrogenous component from squilla and prawn are summarised in Table 1. Yield of the total water soluble fraction from squilla varied between 3.5 and 5% of the fresh raw material and that from the two prawns between 1.8 and 2% respectively. Table 2 presents

Table 1. *Yield of water soluble nitrogen fraction from squilla and prawn*

Raw material	Wt. of fresh material	Wt. of vacuum dried powder from water soluble fraction	Yield
	g	g	%
Squilla Batch 1	1000	50.0	5.0
Squilla Batch 2	1000	35.0	3.5
Squilla Batch 3	1000	42.0	4.2
Squilla Batch 4	1000	40.0	4.0
Squilla Batch 5	1000	35.0	3.5
Squilla Batch 6	1000	38.0	3.8
Prawns *(P. stylifera)*	1000	18.8	1.9
Prawns *(M. affinis)*	1000	21.0	2.1

Table 2. *Yield and distribution of different nitrogen components in the water soluble nitrogen fraction from squilla and prawns*

Raw material	Nitrogen present in raw material			Nitrogen recovered in the water soluble fraction	Percentage of nitrogen recovered in the water soluble fraction	Percentage yield in the water soluble fraction of		
	Total TN A	Chitin CN B	TN–CN A–B			Coagulable nitrogen	Proteose nitrogen	Proteose peptone nitrogen
	mg	mg	mg	mg				
Squilla	1530	180	1350	640	47.4	Not detectable	13.0	67.7
Squilla	1730	210	1520	640	42.1	Not detectable	17.6	60.7
Squilla	1310	200	1110	580	52.3	Traces	15.0	70.0
Squilla	1710	200	1510	730	48.3	Not detectable	14.1	69.5
Prawns *(P. stylifera)*	1730	100	1630	550	33.7	16.5	2.0	40.3
Prawns *(M. affinis)*	2150	100	2050	550	26.8	16.2	8.6	29.9

the relationship of nitrogen recovered in the water soluble fraction to the total nitrogen present in the raw material excluding the chitin nitrogen. Distribution of the individual nitrogenous components in the aqueous extract after removal of protein is shown in Table 2. Recovery as water soluble nitrogen fraction varied between 42–52% in the squilla and between 26.8 and 33.8% in prawns. It is seen from Table 2 that the water soluble fraction from squilla consists mainly of peptones and proteoses and that coagulable protein nitrogen was not detectable in this fraction. In the case of prawns appreciable amounts of coagulable proteins are present and peptones and proteoses are available to a limited extent.

Studies on the growth promoting properties of the samples from squilla have shown that these compared very favourably with Difco and BDH peptones (Iyer, K.M. & Rao, C.C.P., personal communication) in their ability to promote bacterial growth, to serve as source for tryptophan for indole production and to provide a substrate for the production of hydrogen sulphide. The investigations on the effectiveness of the squilla product for incorporation in bacteriological media is not yet completed and the results reported here should be regarded as preliminary.

The authors are thankful to the late Shri G. K. Kuriyan, Director, Central Institute of Fisheries Technology, Cochin for permission to publish the paper.

References

Garg, D. K., Lekshmy Nair, A. & Prabhu, P. V. (1977) *Fish. Technol.* **14,** 53

Madhavan, P. & Ramachandran Nair, K. G. (1975) *Fish. Technol.* **12,** 81

Winton, A. L. & Winton, K. B. (1958) *The Analysis of Foods,* p. 800, John Wiley and Sons, Inc., New York

Fish. Technol. (1982) **19**, 5-7

Report on the Occurrence of One Subspecies of *Scylla serrata* (Forskal) in Cochin Backwaters

C. K. RADHAKRISHNAN and C. T. SAMUEL
Department of Industrial Fisheries, University of Cochin, Cochin-682 016

The taxonomy of the mud crab, *Scylla serrata* has become a topic of interest. Alcock (1899) described this species from Indian waters. It was considered that under the genus *Scylla*, only one species, namely, *Scylla serrata* was valid. But Estampador (1949) revised the genus and reported the occurrence of four sorts, *Scylla serrata*, *S. tranquebarica*, *S. oceanica* and a variety *S. serrata*, var *paramamosain* in Philippine waters. He established his claim based on the morphology such as colouration, relative length of chelae and also on the cytological events during gametogenesis. Serene (1952) pointed out that two distinct categories under this genus was demonstrable on the basis of colouration. But Stephenson & Campbell (1960) concluded them as only synonyms, but pointed out the need for further investigations.

In the present collection from Cochin backwaters two groups of this species with distinct morphological features were noticeable. Male and female animals of different size were collected in large numbers from different locations of the backwaters, the distribution was observed to be rather a mixed one in all parts of the backwaters. The structure of the carapace, the chelae, the first abdominal pleopod of male and colouration were studied. One group which agreed on the earlier description of *Scylla serrata* treated as *Scylla serrata* (Forskal) and the other one which differed is treated as sub-species, namely *Scylla serrata serrata*. A comparison of morphological characters of *S. serrata* and *S. serrata serrata* is presented in Table 1.

Table 1. *Comparison of the morphological characters of the Scylla serrata (Forskal) and Scylla serrata serrata*

Scylla serrata (Forskal)	*Scylla serrata serrata*
Carapace dark green, unsmooth and less convex	Dark green, smooth and more convex
Frontal lobe pointed and anteriorly projected	Not pointed and arranged in the same row
'H' shaped furrow deep	Less deep
Posterior border of the carapace broad and less convex	Comparatively narrow and more convex
Anterolateral teeth not anteriorly truncated	Anteriorly truncated
Ventral side of the carapace white or cream coloured	Bluish colour with reddish tinge, in the anterolateral portion of ventral side
Last pair of walking legs with numerous mosaic like yellow or white patches	Green or violet generally without patches
Chelate leg predominently green with numerous patches with yellow tinge in the lower margin	Orange with brownish green tinge patches are absent or very feeble
Two stout spines are present in the outer angle of the carpus	Only one spine is present
The abdomen of the fully mature females has numerous yellow or white patches	Dark brownish black thick bands are present

Scylla serrata (Forskal)

Carapace is convex, frontal teeth are slightly pointed and anteriorily projected. An 'H' shaped deep furrow is noticeable in the cardiac region of the carapace (Fig. 1 A). Anterolateral teeth are not much anteriorly truncated. The posterior border of the carapace adjoining the abdominal plate is broad, and less convex.

Chelate legs are massive; the merus bears three stout spines in the anterior border (inner angle) and two on the posterior border (outer angle) of which one is terminal and the other one is sub-median in position. The carpus has a strong spine at the inner angle; in the outer angle there exists two stout spines. Propodus is with one stout spine at the front of the apex of the wrist

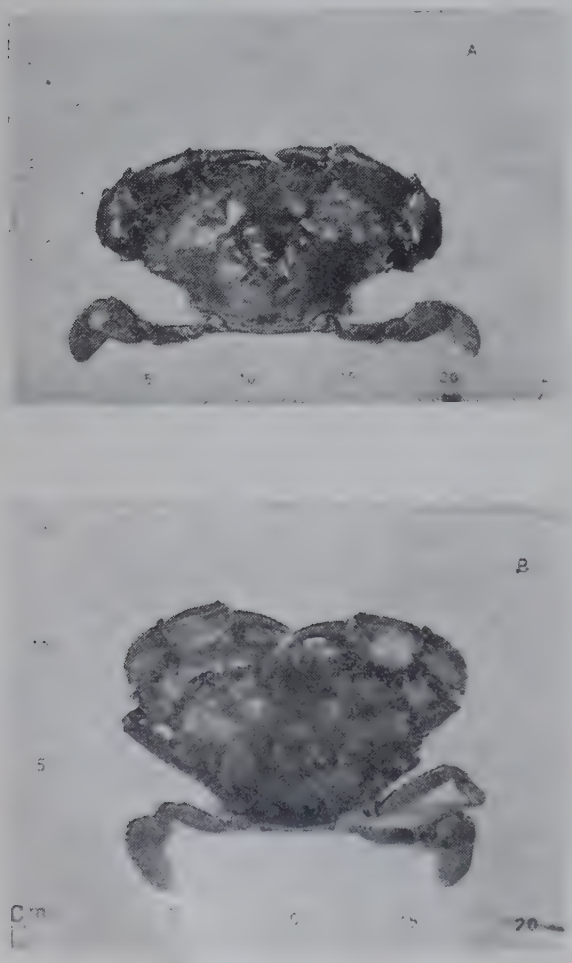


Fig. 1 A. *Scylla serrata* (Forskal)
B. *Scylla serrata serrata*

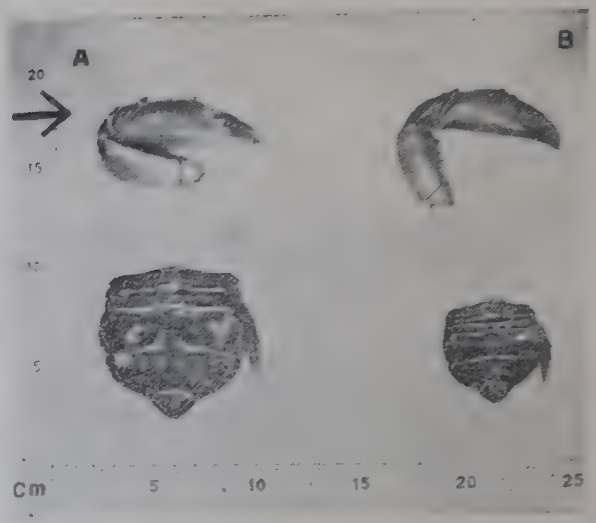


Fig. 2 The chelate legs and the abdominal plates of fully matured females
A. *Scylla serrata* (Forskal)
B. *Scylla serrata serrata*

joint and two small ones located side by side behind the finger joint. The colouration of the carapace is predominently green on the dorsal side and cream on the ventral side. Numerous mosaic–like yellow or white patches are seen on the swimming legs, upper portion of the chelate legs and also on the abdominal flap of the fully mature females (Fig. 2 A).

Scylla serrata serrata

Carapace is convex, frontal teeth are blunt and arranged in one row. The 'H' shaped furrow in the cardiac region is deep. Anterolateral teeth are compactly arranged and are anteriorly truncated (Fig. 1 B). The posterior border of the carapace adjoining the abdominal plate is narrow and convex. The mode of spinulation in the massive chelate leg does not differ from that of the former one except for the carpus, which has only one spine in the outer angle. In general, the spines of the carpus and the dactylus are vestigial in the adult with a broad base and less pointed end. One tubercle is present in the lateral region of the propodus.

The colour of the carapace is shiny green with a smooth surface, mosaic–like patches are sometimes visible on the carapace, but on such patches occur on the chelate leg, swimming legs and abdomen (Fig. 2B).

The ventral side of the carapace is bluish pink. Chelate legs are orange coloured with a brownish green tinge. The abdomen of the fully mature female has a brownish black colour.

Discussion

According to Estampador (1949) Philippine fishermen designate *S. serrata* and the variety paramamosain as belonging to the mamosain group. Vietnam fishermen (Serene, 1952) also recognise four groups, designating as rust red crabs, banana crabs or white crabs, green crabs and moving crabs. Though Serene (1952) does not fully agree with Estampodor in considering them as separate species, he regarded them as species with subdivisions of each varieties. But both agree only in the separation of two distinct groups based on colour. Estampador (1949) considered the relative length of the chelae, and the structure and degree of spinulation as important taxonomic characters. Serene (1952) suggested that the relative length of the chelae alone need not be considered as a diagnostic feature. Similarly Stephenson & Campbell (1960) doubted the diagnostic value of the structure of spines, because of the possibility of wear and tear of spines. In the present investigation the observed number of spines and its degree of sharpening in particular subspecies, irrespective of sex and age, based on an extensive material, may suggest to be of diagnostic value.

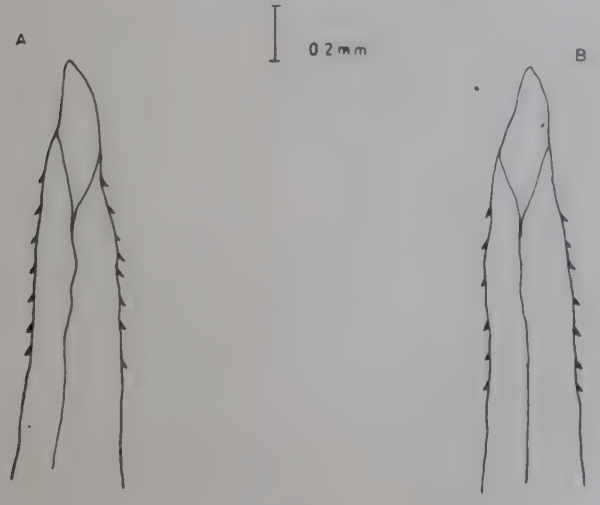


Fig. 3. The first male pleopod enlarged
A. *Scylla serrata* (Forskal)
B. *Scylla serrata serrata*

Taxonomists considered the structure of the first abdominal pleopod of male as a diagnostic feature. But the present study however did not demonstrate any contrasting features in the first abdominal pleopods in both groups suggesting that both groups may not be separate species (Fig. 3).

Gravid females of *S. serrata serrata* have been collected from the backwater near the bar mouth, while no gravid females of *S. serrata* could be noticeable in the backwater. It has been observed that in both forms the abdomen assumes a semicircular shape with well developed pleopods to hold the eggs, on sexual maturity. In *S. serrata* the abdominal flap develops a green colour, with full of yellow mosaic like patches while in *S. serrata serrata,* the colour of the abdomen at this stage is brownish black with dark bands across the flap. In this condition the ovary has a deep pink colour and almost fills the body cavity as observed by Radhakrishnan (1979) in other portunid species. Also, it is interesting to note that both forms differed in the size at maturity. Minimum carapace width observed at maturity in *S. serrata* was 140 mm and abdominal width 61 mm while it was 98 and 43 mm respectively in *S. serrata serrata.*

The authors are thankful to the Department of Science and Technology (Government of Kerala) for financial assistance and the authorities of Cochin University for the facilities.

References

Alcock, A. (1899) *J. Asiat. Soc. Beng.* **68,** 1

Estampador, E.P. (1949) *Philipp. J. Sci.* **78,** 95

Estampador, E. P. (1949) *Philipp. J. Sci.* **78,** 301

Serene, R. (1952) *Proc. Indo. Pacif. Fish. Coun.* 133

Stephenson, W. & Campbell, B. (1960) *Aust. J. mar. Freshwat. Res.* **11,** 73

Radhakrishnan, C.K. (1979) *Studies on the Portunid Crabs of Porto Novo* (Crustacea: Decapoda: Brachyura) *Ph. D. Thesis, Annamalai University*

Fish. Technol. (1982) **19**, 9-14

Survey on the Idle Capacity of Fish Processing (Freezing) Plants in India—II - East Coast

H. KRISHNA IYER, P. SRINIVASA RAO, G. R. UNNITHAN, A. K. KESAVAN NAIR and R. G. NAIR

Central Institute of Fisheries Technology, Cochin-682 029

The extent of idle capacity in the fish processing (freezing) plants in the east coast of India estimated by stratified random sampling and the factors responsible for the same are reported. The estimates of idle capacity of fish processing plants in the east coast for the years 1978 and 1979 were respectively 75.9% and 72.5% on the basis of 250 working days per annum and double shift per day. The percentage errors of estimates worked out to 6.9 for 1978 and 4.7 for 1979. The corresponding figures were worked out on the basis of 200 working days also. Substantial under-utilisation of plants in all the maritime states in the east cost accounted mainly to non-availability of raw material, high cost of production, shortage of power, scarcity of ice and potable water during peak season and frequent labour troubles.

The total coast line of the maritime states in the east coast of India comprising the states of Tamil Nadu, Andhra Pradesh, Orissa and West Bengal is about 2650 km, 47% of the total coast line of India (Anon, 1978). The penaeid prawn landings in the east coast were estimated at 22.8 thousand tonnes in 1979 (Anon, 1979), which formed nearly 20% of the total penaeid prawn landings in India. Freezing of prawns for export started as early as 1968 (Anon, 1978) in this coast. Prior to this period, prawns from Tamil Nadu and Andhra Pradesh were transported to neighbouring states by rail and road. The vast potentiality of raw material, especially bigger sized prawns in this coast and the increased transportation charges over years, paved the way for the establishment of fish processing (freezing) plants in the east coast. In the beginning of 1969 there were hardly a couple of fish processing plants with an annual installed capacity of about six thousand tonnes. Gradually, more and more plants came into existence, and in the beginning of 1979 there were about 94 fish processing plants engaged in freezing of prawns, froglegs and lobster tails. The total installed capacity of these plants was about 120.5 thousand tonnes per year (250 working days in 3 shifts) and the annual production was nearly 22.3 thousand tonnes in 1979. Since these plants depend mostly on seasonal prawn catch, there is every reason to suspect the existence of large idle capacity in plants in this coast. To estimate the extent of idle capacity of the plants and also to identify the causative factors, a survey was conducted during 1980, covering all the maritime states in India. The chief findings of the survey of the east coast states of India are reported in this paper.

Materials and Methods

To estimate the idle capacity of the fish processing plants in India, a stratified random sampling plan was adopted, the strata being freezing plants of under 5 tonnes, 5 to 10 tonnes and above 10 tonnes capacity per day. Allowing a marginal error of 20% on the installed capacity at all India level, 45 freezing plants were sampled, out of a total of 94 on the east coast. Data from the sampled plants were collected through personal interviews for the years 1978 and 1979 as per the proforma prepared for the study. The idle capacity of each sampled plant was worked out by taking the difference between the installed capacity and actual production during the year for single, double and triple shifts for 200 and 250 working days per year. However, under practical conditions, 250 working days per year can be considered to be normal with respect to many organised

industries (Mensinkai, 1969). The idle capacity of the plants in each stratum was estimated first and pooling the stratum estimates at respective levels, the estimates for the states and the east coast as a whole were obtained. The formulae used for the estimation were the same as those described in an earlier communication (Krishna Iyer *et al.*, 1981).

Results and Discussion

The estimates of installed capacity, idle capacity and the percentage error of estimates worked out for single, double and triple shifts by taking 200 and 250 normal working days in a year for 1978 and 1979 are presented in Table 1. The stratum wise and statewise idle capacities for east coast are furnished in Table 2.

Tamil Nadu

Tamil Nadu, one of the important maritime states in the east coast of India has a coast line of about 998 km. Though dry fish export flourished in the state for more than a century, freezing of prawn for export started only in late 1968. The first freezing plant was started in this state some time in 1968 with a daily production of 5 tonnes. As exportable variety of prawn was available in plenty in this state and consequently more and more freezing plants came into existence, so that at the beginning of 1979 there were about 44 freezing plants. Out of these, 21 plants were sampled for estimating the idle capacity, 14 from under 5 tonnes, 5 from 5 to 10 tonnes and 2 from above 10 tonnes daily capacity. The installed capacity of all the plants in the state during 1978 and 1979 for double shift and 250 working days in a year was estimated to be 39.4 and 38.5 thousand tonnes respectively while the actual production estimates were 12.0 and 13.7 thousand tonnes. The idle capacity of the plants for 1978 and 1979 for double shift and 250 working days in a year was estimated at 69.4% and 64.5% and the corresponding triple shift figures were 79.6% and 76.0% (Table 1). Compared to other east coast states, the idle capacity is found to be less in this state. Among different strata (Table 2), plants under 5 tonnes daily capacity had less idle capacity than those in 5 to 10 tonnes and above 10 tonnes capacity per day, in all the 3 shifts, both for 200 and 250 working days in a year for 1978 and 1979. Under 5 tonnes capacity range, the percentage idle capacity for single, double and triple shifts were 21.1, 60.6 and 73.7 in 1978 and 21.8, 60.9 and 73.9 in 1979 respectively when 250 working days in a year were taken. These figures are less than the east coast estimates for plants under 5 tonnes for the three shifts, 51%, 75.5% and 83.7% in 1978 and 44.6%, 72.3% and 81.5% in 1979 respectively. Compared to 1978, the capacity utilisation has slightly increased during 1979. The main factors contributing to the idle capacity of plants in this state were non-availability of raw material, shortage of power and high cost of production. The percentage errors of estimates of idle capacity for 1978 and 1979 with double shift and 250 working days were 15.5 and 9.8 and for triple shifts the corresponding figures were 12.8 and 7.8 respectively.

Andhra Pradesh

Next to Tamil Nadu, Andhra Pradesh has the longest coast line (970 km) on the east coast. Freezing of prawns for export was started in this state as early as 1972. Prior to this, major portion of the prawn landings was transported to neighbouring states, where it was processed and exported. In the beginning of 1979, there were hardly 15 fish processing plants engaged in freezing of prawns, lobster tails and froglegs. 8 plants were sampled for estimating the idle capacity, 4 from under 5 tonnes, 4 from 5 to 10 tonnes capacity per day. There were no plants above 10 tonnes capacity in this state during the survey period. The installed capacity of all the plants in 1979 for double and triple shifts for 250 working days in a year were 12.6 thousand tonnes and 18.9 thousand tonnes respectively, (Table 1), and the estimated production during the year was 3.8 thousand tonnes. The idle capacity of the plants for double shift and for 250 working days in a year for 1978 and 1979 was 77% and 70.1% respectively while the corresponding figures for triple shifts were 84.7% and 80.1%. Though there existed substantial idle capacity of plants in both double and triple shifts, they were less, compared to the east coast figures of 1979. The stratum wise idle capacity

Table 1. *Annual installed capacity and the rate of unutilised capacity (in '000 tonnes of frozen fishery products) in 1978 and 1979 for the states in the east coast of India*

	Single shift				Double shift				Triple shift			
	200 days		250 days		200 days		250 days		200 days		250 days	
	1978	1979	1978	1979	1978	1979	1978	1979	1978	1979	1978	1979
Tamil Nadu												
a) Annual installed capacity	15.8	15.4	19.7	19.3	31.6	30.8	39.4	38.5	47.3	46.2	59.2	57.8
b) Estimated idle capacity	3.7	1.9	7.6	5.6	19.8	17.1	27.4	24.8	35.3	32.5	47.1	43.9
c) % idle capacity	23.4	12.3	38.7	29.1	62.7	55.7	69.4	64.5	74.5	70.5	79.6	76.0
d) % error of the estimate	61.0	77.5	33.5	28.7	18.0	12.1	15.5	9.8	14.0	8.6	12.8	7.8
Andhra Pradesh												
a) Annual installed capacity	5.0	5.0	6.3	6.3	10.0	10.1	12.6	12.6	15.1	15.1	18.8	18.9
b) Estimated idle capacity	2.1	1.3	3.4	2.5	7.2	6.3	9.7	8.8	12.2	11.4	15.9	15.1
c) % idle capacity	42.4	25.2	53.9	40.1	71.2	62.6	77.0	70.1	80.8	75.1	84.7	80.1
d) % error of the estimate	11.0	34.5	5.6	17.5	0.8	7.5	0.5	5.7	1.2	4.8	1.8	4.1
West Bengal												
a) Annual installed capacity	12.8	11.7	16.0	14.6	25.5	23.4	31.9	29.2	38.3	35.1	47.9	43.8
b) Estimated idle capacity	7.5	7.0	10.7	9.9	20.3	18.7	26.6	24.5	33.0	30.4	42.6	39.2
c) % idle capacity	58.7	60.0	67.0	68.0	79.3	80.0	83.5	84.0	86.2	86.7	89.0	89.3
d) % error of the estimate	7.3	5.7	6.0	5.1	4.8	4.6	4.6	4.5	4.4	4.4	4.4	4.4
East coast												
a) Annual installed capacity	33.6	32.1	42.0	40.2	67.1	64.3	83.9	80.3	100.7	96.4	125.9	120.5
b) Estimated idle capacity	13.3	10.2	21.7	18.1	47.2	42.2	63.7	58.2	80.5	74.3	105.6	98.2
c) % idle capacity	39.7	31.6	51.7	45.0	70.3	65.6	75.9	72.5	79.9	77.1	83.9	81.5
d) % error of the estimate	17.5	15.5	12.2	9.6	7.8	5.5	6.9	4.7	6.4	4.2	6.0	3.9

Table 2. *Percentage idle capacity in different strata of each state in the east coast of India for* 1978 *and* 1979

		1978						1979					
		200 days			250 days			200 days			250 days		
	Shifts	U/5	5/10	10 up	U/5	5/10	10 up	U/5	5/10	10 up	U/5	5/10	10 up
Tamil Nadu	I	1.4	57.8	14.3	21.1	66.2	31.5	4.3	11.2	28.9	21.8	28.9	43.1
	II	53.0	78.9	57.2	60.6	83.1	65.1	51.1	55.6	64.5	60.9	64.5	71.6
	III	67.1	85.9	71.5	73.7	88.7	77.2	67.4	70.4	76.3	73.9	75.3	81.0
Andhra Pradesh	I	53.2	27.8	—	62.6	42.2	—	33.7	12.7	—	47.0	30.1	—
	II	76.6	63.9	—	81.3	71.1	—	66.9	56.3	—	73.5	65.1	—
	III	84.4	75.9	—	87.5	80.7	—	77.9	70.9	—	82.3	76.7	—
West Bengal & Orissa	I	68.5	63.4	29.9	74.8	70.7	43.9	58.3	64.4	60.6	66.6	71.6	68.5
	II	84.3	81.7	65.0	87.4	85.4	72.0	79.1	82.2	80.3	83.3	85.8	84.2
	III	89.5	87.8	76.6	91.6	90.2	81.3	86.1	88.2	86.9	88.9	90.5	89.5
East coast	I	38.8	53.0	21.3	51.0	62.4	37.0	31.6	24.1	42.6	44.6	39.3	54.1
	II	70.3	76.5	60.6	75.5	81.2	68.5	65.4	62.1	71.3	72.3	69.7	77.0
	III	79.6	84.3	73.8	83.7	87.5	79.0	76.9	74.7	80.9	81.5	79.2	84.7

of the plants (Table 2) showed that, idle capacity was comparatively less in plants of 5–10 tonnes capacity per day. The figures on the basis of 250 working days in a year for single, double and triple shifts were 42.2%, 71.1% and 80.7% respectively in 1978 and 30.1%, 65.1% and 76.7% respectively in 1979. Also the stratum wise estimates of idle capacity of plants in 5–10 tonnes capacity range were less compared to the corresponding figures for the east coast in 1979; the figures for single, double and triple shifts with 250 working days were 39.3%, 69.7% and 79.2% respectively. Compared to 1978, there were improvements in capacity utilisation in 1979 due to improved prawn landings and freezing of cuttle fish and lobster tails. The major factors responsible for the underutilisation of plants in the state were, shortage and high cost of raw material (prawns) for processing and shortage of power. The percentage errors of estimates worked out for 1978 and 1979 for double shift with 250 working days in a year were 0.5 and 5.7 and for triple shifts these figures were 1.8 and 4.1 respectively.

West Bengal and Orissa

The states of West Bengal and Orissa have a combined coast line of about 680 km of which 200 km are in West Bengal. Freezing of prawns for export started here in 1971. During 1979, there were 35 freezing plants of which 11 were in Orissa. A sample of 16 plants was selected for estimating the idle capacity of which 11 were under 5 tonnes, 2 were 5 to 10 tonnes and 3 were above 10 tonnes capacity per day. The estimated installed capacity of all the plants in these two states with double shift and 250 working days in a year was 31.9 and 29.2 thousand tonnes during 1978 and 1979 respectively while the estimated production for these two years was respectively 5.3 and 4.7 thousand tonnes (Table 1). The estimated idle capacity of the plants for 1978 and 1979 with double shift and 250 working days in a year was 83.5% and 84.0% respectively and for triple shift the corresponding figures were 89% and 89.3% respectively. Among the east coast states idle capacity was maximum in West Bengal and Orissa in all the 3 shifts and in both the years. The stratum wise figures for idle capacity (Table 2) showed that for plants under 5 tonnes daily capacity, the percentage of idle capacity for single, double and triple shifts were respectively 74.8, 87.4 and 91.6 in 1978 and 66.6, 83.3 and 88.9 in 1979 for 250 working days. These figures were comparatively larger than the east coast figures for the 3 shifts, 51.0%, 75.5% and 83.7% in 1978 and 44.6%, 72.3% and 81.5% in 1979. In plants of 5–10 tonnes capacity range, the percentage idle capacity remained more or less the same in both the years. For the plants above 10 tonnes capacity range, the percentage idle capacity was more in 1979 compared to 1978 in all the three shifts. The major factors contributing to the large idle capacity of the plants in these states were (1) non-availability of raw material (2) power shortage (3) labour problems and (4) high cost of production. The errors of estimates of idle capacity for double shift with 250 working days for 1978 and 1979 were respectively 4.6% and 4.5%.

It is evident from the foregoing discussion that there existed a considerable amount of idle capacity in the fish processing plants in the east coast of India. The idle capacity estimated for the plants in the east coast on the basis of 250 working days with double shift per day during 1978 and 1979 was respectively 75.9% and 72.5% and for triple shift these figures were respectively 83.9% and 81.5%. The percentage errors of estimates of idle capacity for double shift with 250 working days in 1978 and 1979 were 6.9 and 4.7 respectively and for triple shifts they were 6.0 and 3.9 respectively, indicating that the sampling errors are within usual limits.

The factors responsible for the large idle capacity of plants in east coast are listed in Table 3. It may be noted that non-availability of raw material was the prime factor responsible for the substantial under utilisation of plants in this coast. Shortage of power, high cost of production, shortage of ice and potable water during peak season and labour problems were other major factors contributing to the under utilisation of plants.

Table 3. *Factors responsible for under-utilisation of plants in the east coast of India*

Factors	% of processors reported the factor in the sample
Non-availability of raw material	82.2
Power shortage	62.2
High cost of production	53.3
Shortage of ice during peak season	24.4
Labour problems	20.0
Shortage of potable water during peak season	15.6
Lack of transport facilities	13.3
Lack of cold storage facilities	4.4
Unsteady foreign market	4.4
Competition of processors from other states in procuring the raw material	4.4
Lack of technical hands	2.2

Based on the findings of the survey, following are a few recommendations which may help to reduce the idle capacity of fish processing plants in this coast.

1. Promoting mass aquaculture of prawns to meet the raw material shortage.
2. Exploration of new prawn grounds and introduction of more and more deep sea fishing trawlers to boost up prawn catch.
3. Subsidy on diesel oil to all classes of fishing vessels
4. Diversification of products
5. Steady supply of power
6. Abolition of purchase tax on raw material
7. Check on movement of raw material from one state to the other
8. Control on issuing licence to new entrepreneurs
9. Improved shipping facilities
10. Liberalisation on financial assistance/ subsidy to processors
11. Improving cold storage facilities
12. Fixing a floor price for fishery products

The authors wish to express their deep sense of gratitude to all the fish processors in the east coast of India for extending their whole hearted co-operation in the study. They are also thankful to Dr. C. C. P. Rao, Director, Central Institute of Fisheries Technology and Dr. P. N. Kaul, Scientist-in-Charge, Extension, Information and Statistics Division, Central Institute of Fisheries Technology, Cochin–682 029, for encouragement.

References

Anon (1978) *'Export Potential of Marine Products in Tamil Nadu.'* The Marine Products Export Development Authority, Cochin.

Anon (1979) *Statistics of Marine Products Exports.* The Marine Products Export Development Authority, Cochin.

Krishna Iyer, H., Srinivasa Rao, P., Unnithan, G. R., Kesavan Nair, A. K. & Nair, R. G. (1981) *Fish. Technol.* **18,** 109

Mensinkai, S. S. (1969) *Can. Fish. Rep.* **11,** 18

Fish. Technol. (1982) **19**, 15-18

Experimental Trawling in Hirakud Reservoir

V. C. GEORGE, PERCY DAWSON, A. A. KHAN and M. D. VARGHESE
Burla Research Centre of Central Institute of Fisheries Technology, Burla-768 017

Results of trawl fishing experiments conducted in Hirakud reservoir are discussed. Trawling has been found to be efficient than conventional gear in removing predators and trash fishes especially of the bottom. This method can be of much help in controlling the proliferation of such fishes in many Indian reservoirs.

India has vast inland water resources spread throughout the country. The water spread area of these reservoirs covers about 3 million hectares. The bottom of many reservoirs possessed submerged forests, ruins, rocks, stones and other obstacles (Gulbadamov, 1962; Znamensky, 1967 & Natarajan, 1976). The presence of these underwater obstructions limits the use of active gear in most of the Indian reservoirs (Sulochanan *et al.*, 1968; Kuriyan, 1973). Due to such obstructions passive gears such as set gill nets are apparently the only types possible (Kuriyan, 1973).

In reservoirs that are constructed recently, adequate measures like de-forestation and clearing of the boulders and other obstacles are being taken for fishery purpose. This will greatly help the introduction of active gear like trawls and shore seines for the exploitation of fishery resources.

Even though trawl fishing is well established in marine waters, it is yet to make a beginning in Indian reservoirs and lakes. According to Meschkat (1956) trawl fishing is done at Lake Dojran in Yugoslavia to catch big carps, cat fishes and perches. Ellis & Pickering (1973) reported that carps dominated all trawl drags in Saginaw Bay area of Lake Huron. Bottom trawl experiments conducted at lake Rudolf, Kenya, showed that non cichild fish formed a high proportion of catch in all areas and tilapia were caught in appreciable numbers only in sheltered waters (Hopson, 1975). Tests carried out in Lake Constance, West Germany, led to wider use of small pelagic trawls in lake fisheries (Anon, 1979). In Federal Republic of Germany, two boat bottom trawling was done as most of the boats had only small engines (Steinberg 1964).

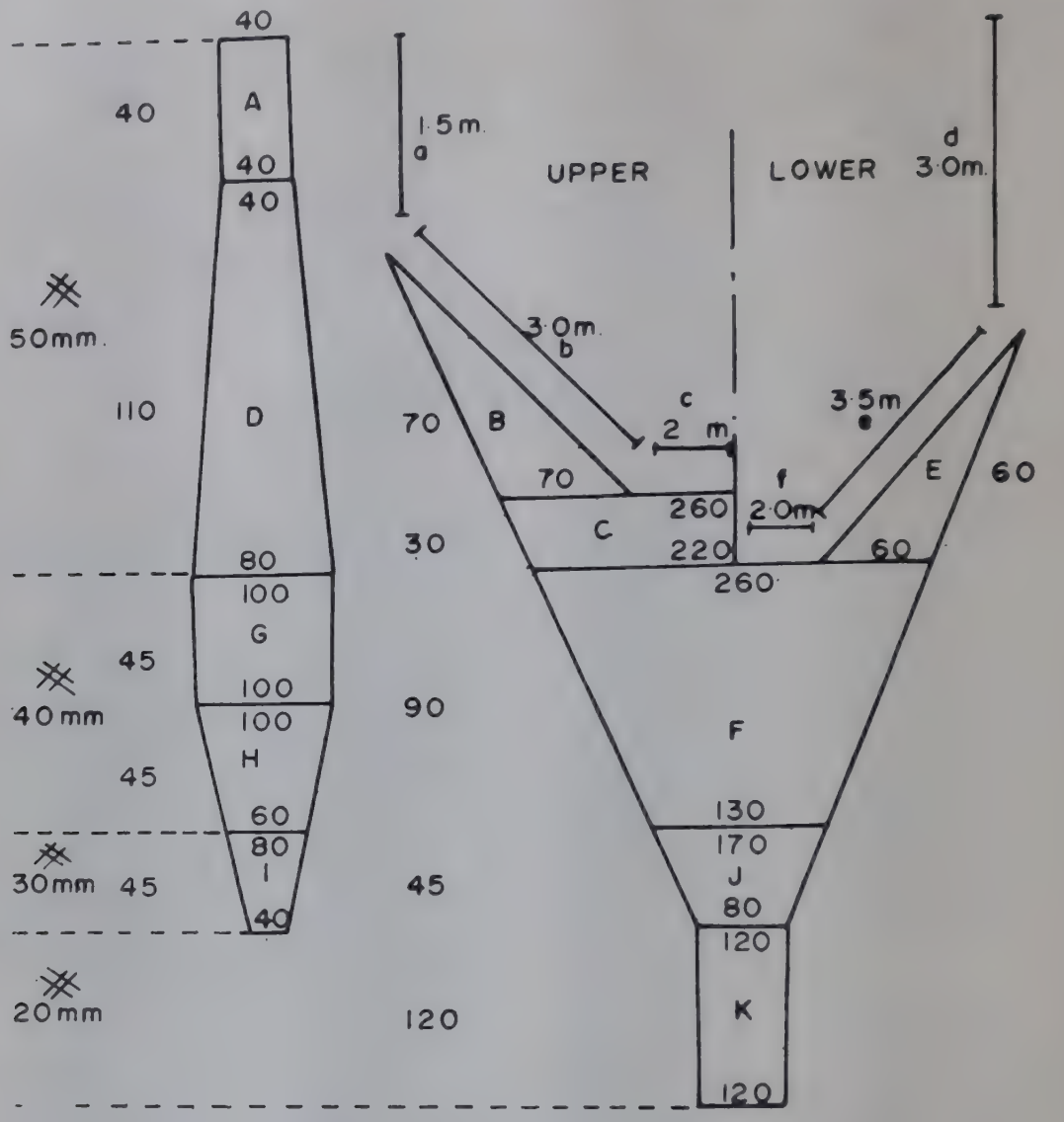
Recent studies on the species-wise landings from Hirakud reservoir (Varghese *et al.*, 1981) revealed that the cat fish and trash fish together constituted 68.36% of the total catch and the rest were carps. The fishery of this reservoir is mainly exploited with gill nets and lines. But in view of the sparse nature of fish population, Znamensky (1967) suggested the use of active gear like trawls. This paper reports the attempt on experimental trawling in Hirakud reservoir by the authors.

Topography of Hirakud reservoir

The Hirakud reservoir formed across Mahanadi river in Orissa has possibly the largest water spread of 74,592 hectares with a shore line of 643.6 km at the maximum water level of 192.15 m from mean sea level. The reservoir is generally shallow with middle and lower reaches deeper than other regions. Though the reservoir bed is littered with stones, boulders and tree stumps, there are areas of soft bottom caused by silting, particularly the river beds. Hence, fishing could be done mainly in the silted area of the river course, and in the upper and middle reaches of the reservoir.

Materials and Methods

Experiments were conducted in the upper and middle reaches from January 1979 to March 1979 and from September 1979 to October 1979. Trawling could not be



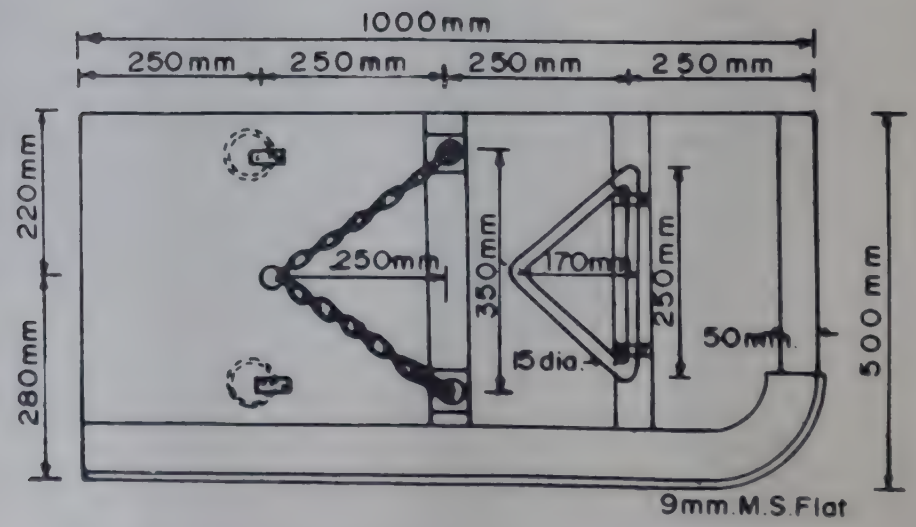


Fig. 1. 13m bulged belly and otter trawl

undertaken during pre-monsoon and monsoon months due to heavy winds and flood waters causing strong currents. A 13 m bulged belly trawl (Fig. 1) was operated from 9.1 m boat powered by 40.7 HP engine. Mainly bottom trawling was attempted.

Trawling was done at a towing speed of 1.942 knots at depths 6–12 m. Each haul was generally of 20 min duration. The catch per effort was calculated in kg/h of trawling. The depth-warp ratio was fixed as 1:3. A total of 155 hauls were made. The risk of running over gill nets and lines limited the duration as well as area of operation.

Results and Discussion

The species wise composition by weight and their percentage is given in Table 1. It could be seen that cat fishes formed 38.2% by weight of the total catch and the rest were trash fishes. The catch/h was worked out as 19.4 kg.

The virtual absence of major carps in the catch revealed that this gear may not be a destructive gear to the fishery. Hence, in reservoirs where there is predominance of cat fishes and trash fishes, this method may be adopted to check further proliferation of these fishes.

Table 1. *Species composition of fishes*

Species	Weight kg	Percentage
Mystus seenghala (Sykes)	155.71	14.60
Mystus aor (Hamilton)	117.50	11.01
Wallago attu (Schneider)	48.40	4.54
Rita chrysea (Day)	62.68	5.87
Rohtee cotio (Day)	522.08	48.92
Notopterus chitala (Day)	28.0	2.62
Silonia silondia, Ailia coila (Hamilton) and others	132.80	12.44
Total	1067.17	100.00

Table 2. *Details of* 13 *m bulged belly trawl*

	A	B	C	D	E	F	G	H	I	J	K
Stretched mesh (mm)	50	50	50	50	50	40	40	40	30	30	20
Upper edge mesh	40	1	260	40	1	260	100	100	80	170	120
Lower edge mesh	40	70	220	80	60	130	100	60	40	80	120
Depth mesh	40	70/140	30	110	60/120	90	45	45	45	45	120
No. of pieces	2	2	1	2	2	2	2	2	2	2	2
Cutting rate	Allp	lp2b	lp4b	2plb	lp2b	lp5b	Allp	3p8b	5p8b	5p8b	Allp
Hanging coefficient	75%	55%	50%	75%	55%	50%					
Rope length m	a=1.5 b=3.0 c=2.0 d=3.0 e=3.5 f=2.0										
Material	A–J 1mm. dia Garfil blue colour										
Weight of net	28 kg										

It is to be pointed out that there is no efficient method to exploit the deep water fishery resources of reservoirs. Gorman (1965) suggested to operate trawl nets to exploit bottom dwellers like bream, where conventional gear is not effective in exploiting the deep water fishery. The occurrence of bottom/off bottom fishes like sciaenids, *N. notopterus, R. chrysea, Mystus* sp. and *R. cotio* indicate that bottom trawling is effective for the removal of those fishes.

The results obtained through bottom trawling in Hirakud reservoir provide scope for introducing this technique in other reservoirs. Experimental trawling could be successfully carried out in the silted area of the reservoir bed and in the river course.

The significance of trawling should also be viewed not only from the commercial point of view but also from the management aspect. According to Natarajan (1975) most of the cat fishes are predatory in nature and their proliferation affect the recruitment potential of major carps and suppress their development to below optimum level which suggests the eradication of predators and trash fishes. National commission on Agriculture (Anon, 1976) has also expressed similar views. Further the existing methods like gill netting and lines perclude the capture of small trash fishes and bottom dwellers.

The authors wish to express their thanks to Dr. C. C. Panduranga Rao, Director, Central Institute of Fisheries Technology, Cochin for permission to publish this paper and also to the late Shri G. K. Kuriyan, former Director for encouragement and guidance.

References

Anon (1976) *Report on the National Commission on Agriculture. Part viii* (Fisheries) p. 389, Government of India, Ministry of Agriculture and Irrigation, New Delhi

Anon (1979) *Fish News int.* **18,** 12

Ellis, J. E. & Pickering, E. N. (1973) *Trans. Am. Fish. Soc.* **1,** 116

Gorman, T. B. S. (1965) *Wld Fishg.* **14,** 70

Gulbadamov, S. B. (1962) *Report to the Government of India on the Improvement of Fishing Techniques in Inland Reservoirs of India.* FAP/EPTA, **1342,** 1

Hopson, A. J. (1975) *Afr. J. Trop. Hydrobiol. Fish.* **4,** 79

Kuriyan, G. K. (1973) *Fish. Technol.* **10,** 1

Meschkat, A. (1956) *FAO Report to the Government of Yugoslavia,* **555,** 15

Natarajan, A. V. (1975) *Indian Farming* **25** (b) 33

Natarajan, A. V. (1976) *Symposium on the Development and Utilisation of Inland Fishery Resources.* IPFC/1976/SYM, 1

Steinberg, R. (1964) in *Modern Fishing Gear of the World.* (Kristjonsson, H. Ed.) vol. 3, p. 423, Fishing News Books Ltd., London

Sulochanan, P., George, V. C. & Naidu, R. M. (1968) *Fish. Technol.* **5,** 81

Varghese, M. D., Kesavan Nair, A. K., George, V. C. & Khan, A. A. (1981) *Fish. Technol.* **18,** 17

Znamensky, Yu (1967) *Report to the Government of India on the Development of Fishing Techniques in the Hirakud, Nissam Sagar Water Resources and the Affluents,* FAO. TA **2290,** 1

Fish. Technol. (1982) **19**, 19-23

Biochemical Changes of Fish Fingers Held at Frozen Storage

P. RAVINDRANATHAN NAIR, R. THANKAMMA and K. GOPAKUMAR
Central Institute of Fisheries Technology, Cochin-682 029

The frozen storage characteristics of fish fingers made out of two different species, differing in lipid content for a period of six months are outlined. The study reveals that the lipid content of the fish meat used for making fish fingers influences the storage pattern in terms of the chemical parameters like peroxide value, thiobarbituric acid value and free fatty acids. The introduction of monosodium glutamate has improved the flavour of the fish fingers. Further, the application of batter on the fish fingers imparted some protective effect in the case of semi-fatty fish.

In India fishing industry is largely export oriented. Eighty per cent of the country's exported commodities is comprised of prawns. Prawns are caught by trawling. In these trawlers, 50–70% of the total catch is constituted by miscellaneous fish and the rest by shrimp. Diversified speciality products from these miscellaneous fishes will certainly enhance the commercial value of these bycatch. One of the well-known fish product that can be profitably produced and marketed from these low priced fishes is fish fingers. Very little study has been done in the country on the manufacturing and frozen storage characteristics of the fish fingers. An attempt has been made to develop and study the storage pattern of fish fingers from two species of fishes, namely, the threadfin bream and the horse mackerel (Family *Carangidae*). The paper reports the storage characteristics of fish fingers made from these two species of fish and kept under frozen condition.

Materials and Methods

Fish fingers were prepared from fresh threadfin bream by using minced meat prepared using a meat picking machine. The minced meat obtained was divided into three portions and labelled as C_1, C_2 and C_3. In the sample C_3, 0.01% mono-sodium glutamate (MSG) was added after dissolving in water. Sufficient quantity of water (50 ml/300 g meat) was added in all the three samples to make a uniform dough and packed in waxed cartons after covering with polythene film. The samples were quick frozen at –40°C and stored at –18°C in a freezer. The samples were cut into proper size (6 x 1.5 x 1 cm) and packed in polythene film and kept in the same cartons in the freezer. A suitable batter has been formulated using wheat flour (50 g), milk powder (75 g), whole eggs (2 nos) and water (100 ml). The frozen fish fingers were dipped in the batter and rolled over dry bread powder. Out of the three samples C_1, C_2 and C_3, only C_2 and C_3 were battered and breaded and sample C_1 was the control. All the samples were fried in refined groundnut oil for 7 min and the fried samples were packed in polythene lined waxed cartons and kept in the freezer at –18°C.

Immediately after frying, the samples were taken for initial analysis. Periodic analysis of the samples were conducted after every month for a period of six months. Moisture, fat and protein were determined by A.O.A.C. method (1975), peroxide and free fatty acid values by the methods of Lea (1952) and A. O. C. S. (1946) respectively. The thiobarbituric acid value was estimated by the method of Tarladgis *et al.*, (1960).

This study was extended to the semi-fatty fish (horse mackerel). Similarly, fish finger samples C_1, C_2 and C_3 were prepared from horse mackerel and kept in frozen storage to compare their behaviour with those prepared from threadfin bream. The method of preparation, sampling, storage conditions

and parameters of chemical analysis were carried out in the same way as with the samples made out of threadfin bream.

Results and Discussion

The changes in moisture content of the two species are presented in Tables 1A and 1B. In all the three samples of fish fingers, from both the species, the initial moisture was high. Among the three samples, the sample C_3, which was treated with monosodium glutamate, showed higher moisture content during storage for both the species.

The variations in fat content are given in Tables 2A and 2B. Depending on the change in moisture content, a corresponding change in fat content is also observed. The variation in lipid content was almost the same for all the three samples for both the species of fishes.

Table 1A. *Changes in moisture content of fish fingers from threadfin bream stored at* —18°C

	Period of storage in months						
Samples	0	1	2	3	4	5	6
C_1	48.70	48.68	44.97	46.64	47.0	48.42	48.17
C_2	48.70	46.5	—	46.95	46.27	46.45	48.95
C_3	53.18	52.08	48.37	47.5	47.58	47.6	47.84

Table 1B. *Changes in moisture content of fish fingers from horse mackerel stored at* —18° C

	Period of storage in months						
Samples	0	1	2	3	4	5	6
C_1	34.82	29.19	33.24	33.24	35.34	31.06	28.64
C_2	33.32	30.31	30.84	35.10	—	34.88	35.62
C_3	35.75	—	34.02	39.26	40.39	37.84	35.44

Table 2A. *Changes in lipid content of fish fingers from threadfin bream stored at* —18°C

	Period of storage in months						
Samples	0	1	2	3	4	5	6
C_1	10.22	13.77	14.50	15.92	13.50	12.63	11.68
C_2	12.81	15.25	15.10	15.55	15.10	14.25	14.17
C_3	12.25	15.92	15.24	15.60	12.67	11.88	11.50

Table 2B. *Changes in lipid content of fish fingers from horse mackerel stored at* —18°C

	Period of storage in months						
Samples	0	1	2	3	4	5	6
C_1	19.13	22.57	20.69	20.46	19.18	20.97	22.00
C_2	23.04	21.14	23.95	20.04	20.09	21.51	20.19
C_3	20.37	17.56	21.12	18.67	17.91	19.70	19.75

Table 3A. *Changes in protein contents of fish fingers from threadfin bream stored at —18°C*

	Period of storage in months						
Samples	0	1	2	3	4	5	6
C_1	32.79	29.00	37.00	37.10	36.00	38.24	36.35
C_2	22.14	21.40	22.57	23.62	25.16	24.19	24.30
C_3	21.17	19.29	23.10	23.01	25.68	23.36	22.74

Table 3B. *Changes in protein content of fish fingers from horse mackerel stored at —18°C*

	Period of storage in months						
Samples	0	1	2	3	4	5	6
C_1	41.77	42.87	45.40	45.14	46.19	49.12	42.67
C_2	31.54	26.77	29.55	31.24	30.97	34.41	28.39
C_3	30.97	24.50	34.64	35.37	27.97	30.44	26.96

The protein changes of the fish fingers due to storage are presented in the Tables 3A and 3B for both the species of fishes. There was a decrease in the protein content after a storage period of one month for all the three samples for both the species and then the value increased gradually and at the end of the storage period the value again decreased. The samples C_1 showed a high value for protein among the samples studied from both the species of fishes since the meat content in that sample was the highest compared to the other samples. The samples C_2 and C_3 (both battered) showed a similar change in protein during storage avoiding any significantly drastic changes. In general, alterations in moisture, fat and protein values were only marginal.

The peroxide value and free fatty acid value changes due to frozen storage of the fish fingers from both the species are presented in Figs. 1A, 1B and 2A, 2B respectively. The pattern of behaviour of the fish fingers made out of threadfin bream and horse mackerel in terms of peroxide value was quite different. In the case of threadfin bream samples, the maximum peroxide value was obtained during the initial analysis, that is, immediately after frying. The values decreased considerably during initial period of storage upto two months and then increased gradually during the latter half of the storage period. Samples C_2 and C_3 (both battered) showed a close similarity while in the case of C_1 (without batter), the peroxide value increased considerably in the latter half of storage. In the case of the fish fingers from horse mackerel all the three samples C_1, C_2 and C_3 reached the peak value at the end of four months and then it began to fall and at the end of six months the value dropped to the minimum. Among the three samples, the sample C_1 showed the maximum value for peroxide throughout the storage period. The high initial peroxide value and a similar trend in behaviour after a deep fall during the first month of storage for the samples made out of threadfin bream indicates that the values are

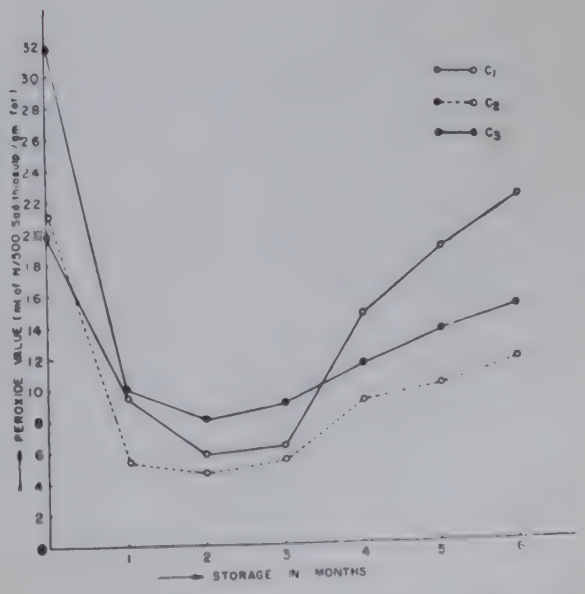


Fig. 1 A. Changes in peroxide value of fish fingers prepared from threadfin bream and stored at–18°C.

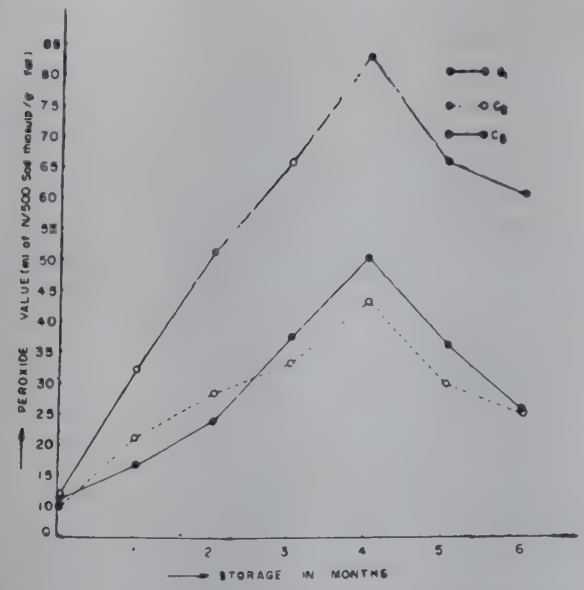


Fig. 1 B. Changes in peroxide value of fish fingers prepared from horse mackerel and stored at–18°C.

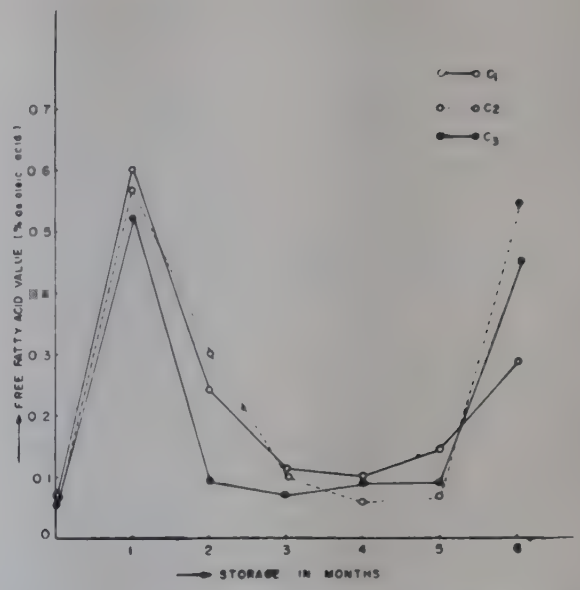


Fig. 2 A. Changes in free fatty acid value of fish fingers prepared from threadfin bream and stored at–18°C.

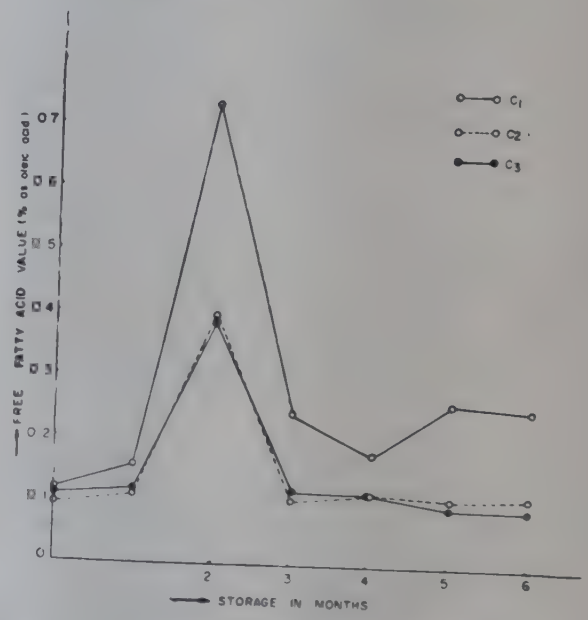


Fig. 2 B. Changes in free fatty acid value of fish fingers prepared from horse mackerel and stored at–18°C.

mainly due to the oil used for frying in the case of lean fish. The gradual rise in peroxide value in semi-fatty fish (horse mackerel) samples may be due to the fact that the batter might have offered a protective coating and consequently the autoxidation of the fish lipids may be delayed to a great extent. The fact that the sample C_1 showed higher values compared to the battered samples also indicates the protective nature of the batter.

Initially, the free fatty acid values for all the three samples were quite low but showed its peak after one month in the case of threadfin bream. Then the values decreased gradually for a period of four months and then increased during the latter period of storage. The sample C_1 showed only marginal increase in free fatty acid after four months storage compared to others. The storage behaviour of the fish fingers made out of the horse mackerel was also similar to those from threadfin bream. Initially the values were quite low for all the three samples and then it began to increase slowly for one month and reached the peak after two months with a steep fall after three months storage in frozen condition and thereafter the values did not show much change till the end of six months. The difference in the peak values for the samples from threadfin bream and horse mackerel may be due to the difference in the quantity of active components of the two species of fish meat as well as the nature of the fat present in unit weight of the meat, as the frying medium was same for all the samples.

The change in thio-barbituric acid (T.B.A) number due to frozen storage of the samples from both the species are represented in

Figs. 3A and 3B. In the case of threadfin bream samples, all the three samples showed lower values during the latter period of storage. The initial value was quite high for the sample C_1 compared to the other two. Then after one month storage, the value dropped down considerably and then slowly decreased upto five months and finally it started to increase. In the case of the sample C_3, there was an initial drop in the value after two months and afterwards the change was almost similar to the other samples. But in the case of all the samples prepared from horse mackerel, initially the T.B.A. value have been very low and then it began to increase gradually till the end of three months and thereafter the value decreased slightly till the end of six months. The T.B.A. value was maximum for the sample C_1 compared to other samples. Sample C_2 and C_3 behaved very closely for thiobartiburic acid value throughout the storage period. The decrease of thiobarbituric acid values in the battered samples could be due to T.B.A. type compounds with the amino acids and peptides released from the proteins of the batter. No direct correlation between thio-barbituric acid value and peroxide value of both the species could be obtained since in case of fatty fish, unsaturated fatty acids from the fish muscle also might have contributed to the total values.

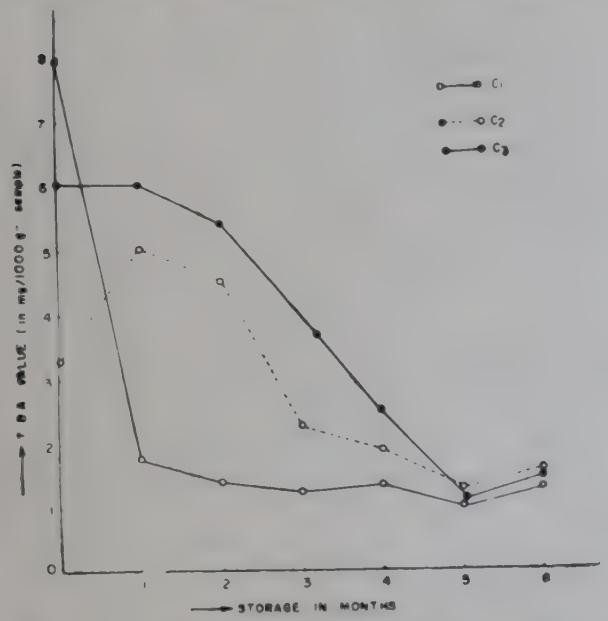


Fig. 3 A. Changes in thiobarbituric acid value of fish fingers prepared from threadfin bream and stored at–18°C.

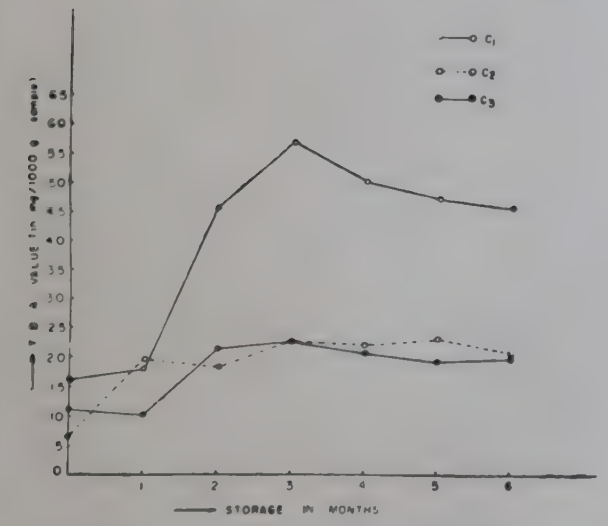


Fig. 3 B. Changes in thiobarbituric acid value of fish fingers prepared from horse mackerel and stored at–18° C.

The peculiarity observed in the study is that the control sample from horse mackerel (without batter) has shown a marked increase in peroxide value, free fatty acid value and thio-barbituric acid value in comparison with the other samples which are battered. In the case of lean fish (threadfin bream) samples, this behaviour although seen, was not markedly significant. In the case of semi-fatty fish (horse mackerel), it can be assumed that the samples C_2 and C_3 showed lower peroxide, free fatty acid and thiobarbituric acid values because of the protective effect imparted to them by the batter. This aspect is not very prominent for fish fingers from threadfin bream, as the fat content in the picked meat is lower than that of horse mackerel. The M.S.G. incorporated samples had better flavour compared to other samples.

The authors express their gratitude to the Director, Central Institute of Fisheries Technology, Cochin for his kind permission to publish this paper.

References

A.O.A.C. (1975) *Official Methods of Analysis* (Horwitz, W Ed.) 12th Edn., Association of Official Analytical Chemists, Washington

A.O.C.S. (1946) *Official and Tentative Methods* (A.O.C.S. Chicago) Ca, 5A-40

Lea, C. H. (1952) *J. Sci. Fd Agric.* **3**, 586

Tarladgis, B. G., Watts, B. M., Margaret T. Y., & Dugan, L. (1960) *J. Am. Oil Chem. Soc.* **37**, 44

Fish. Technol. (1982) **19**, 25-28

Processing Clam Meat into Pickles

P. K. VIJAYAN, P. A. PERIGREEN, P. K. SURENDRAN and K. K. BALACHANDRAN
Central Institute of Fisheries Technology, Cochin-682 029

Methods have been worked out for the production of pickles from clam (*Velorita* sp.) meat. The bacteriological quality of the clam meat at different stages of processing was studied. The clam pickles packed in glass bottles and sealed air tight remained in good condition for six months at ambient temperatures.

Clam is a bivalve found in large quantities in brackish water lakes, estuaries and bar mouths. In Kerala, Vembanad lake is known to be the richest source of clams. Ashtamudi lake and several other inland water bodies abound in clams. Clam fishery of Kerala predominantly is centered round two species, *Velorita* and *Meretrix*. Clam is generally fished for its shell which is a very important raw material in several industries like cement, calcium carbide and lime. Clams are collected and heaped in the open to allow the meat to decay and thus to get rid of it except in few cases where it is boiled, the meat shucked out and sold in the areas nearby.

Clam on cooking and shucking yields an average of 9% meat. It has been roughly estimated that about 2400 tonnes of clam meat is available from Vembanad lake alone (Sebastian, 1970). This together with its availability from several other sources contribute to a substantial quantity. The fact that only a negligible portion is utilised for food purposes tells the story of the wastage of a nutritious food.

Clam meat is rich in protein, tasty and is relatively high in glycogen, similar to prawns and crabs. However, no attempt is made to process it to stable products to prevent wastage. Venkataraman & Chari (1951) studied the seasonal variation in chemical composition of clam meat. Sebastian (1970) has given an account of canning clams. Balachandran & Nair (1975) worked out a method of depuration and its canning.

Clam meat renders itsef well for processing into pickles by low cost technology and can be taken up by the rural people economically where clams are fished in large numbers and will provide employment for many. Hence this study on pickling of clam meat has been taken up.

Materials and Methods

Clams *(Velorita* sp.*)* were collected from the Vembanad lake near Vaikom in Kerala. After washing free of mud and sand in the lake water, the clams were allowed to starve for 24 h in clean lake water for depuration followed by keeping them in chlorinated (5 p.p.m.) water for 2 h in order to get rid of the sand in the stomach. Clams were steamed until they opened the shell and the meat was shucked out by hand. The meat was pickled in two ways, fresh and also after blanching in boiling brine of 5% strength for 8 min. Of the several recipes tried, two were found organoleptically more suitable based on shucked meat as such, as well as after blanching in brine.

Ingredients used in the preparation of pickle using shucked clam meat was as follows:

1.	Clam meat shucked	1000 g
2.	Mustard seeds	10 g
3.	Green chilly (cut to pieces)	50 g
4.	Garlic (peeled)	80 g
5.	Ginger (peeled and chopped)	180 g
6.	Chilly powder	35 g
7.	Turmeric powder	2 g
8.	Gingelly oil	250 ml
9.	Vinegar (3% acetic acid)	450 ml
10.	Salt (approx.)	100 ml
11.	Water (boiled and cooled)	400 to 600 ml

Fried the clam meat in minimum oil for about 45 min and set apart. Fried the ingredients 2 to 5 in the remaining quantity of oil and then added chilly powder and turmeric and mixed well under low flame for a few minutes. Removed from fire and mixed the fried clam meat with vinegar and sufficient quantity of boiled and cooled water to completely cover the ingredients. Mixed thoroughly and added salt to taste.

After mixing together all the ingredients, the pickle was left to 'mature' for two days and then packed in clean dry bottles (350 g) and sealed air tight with acid proof caps. While packing care was taken to prevent the exposition of meat and a layer of oil was always kept covering the pickle at the top and previously heated and cooled gingelly oil was added if necessary to ensure a protective layer of oil at the top. The products were stored for a period of 8 months in bottles at room temperature and periodically examined organoleptically and bacteriologically.

Moisture, fat, protein, ash and acid insolubles in shucked clam meat were estimated by the methods of AOAC (1955) and glycogen by the method of Kleiy (1951). The viable plate count (TPC) was determined using tryptone glucose agar (TGA). The plates were incubated at 29 ± 1°C (RT) for 48 h and counts taken. Total coliforms were determined using desoxy cholate citrate agar (DCA), *Escherichia coli* using tergitol-7-agar (T7), streptococci using KF agar and coagulase positive *Staphylococcus* using Baird-Parker agar (FDA, 1973; Difco, 1971). Salmonella was detected by pre-enrichment in lactose broth followed by enrichment in tetrathionate broth. The tetrathionate broth culture was streaked on brilliant green sulphadiazine agar and incubated at 37°C for 24 h. Characteristic colonies were inoculated to triple sugar iron agar (TSI) and cultures giving characteristic reaction were further identified biochemically and serologically (Galton *et al.*, 1968). The organoleptic quality was determined by a panel of trained persons.

Results and Discussion

The proximate composition of shucked clam meat is given in Table 1. The bacteriological quality of raw clam meat before and after depuration and steamed and shucked clam meat is presented in Table 2. Depuration reduced the total plate count (TPC)

Table 1. *Proximate composition of clam meat*

Moisture %	78.50
Fat %	2.52
Protein %	10.09
Ash %	0.86
Acid insolubles %	0.38
Glycogen %	6.68

Table 2. *Bacteriological quality of raw clam meat, depurated clam meat and shucked clam meat*

	Raw clam meat		
	Before depuration	After depuration	Shucked clam meat
Total viable plate count per g	1.2×10^8	5.5×10^6	3.1×10^3
Total coliforms per g	6.3×10^3	8×10^2	50
E. coli per g	3×10^3	3.5×10^2	Nil
Streptococci per g	8.5×10^3	5×10^2	Nil
Coagulase positive *Staphylococcus*	Nil	Nil	Nil
Salmonella	Nil	Nil	Nil

Table 3. *Changes in bacteriological and organoleptic characteristics of clam pickle*

Storage period month	TPC/g	Organoleptic quality
0	6.217×10^3	Good colour; tough texture; good flavour
1	2.30×10^3	Good colour; moderately soft texture; good flavour
2	1.02×10^3	–do–
3	4.10×10^3	–do–
4	2.845×10^2	–do–
6	2.046×10^2	Colour slightly faded; soft texture; good flavour
8	3.203×10^2	Dull colour; soft texture; slight off flavour

Coliforms, streptococci, coagulase positive *Staphylococcus* and salmonella were absent.

considerably (to about 50%) and steaming and shucking gave clam meat of low bacterial count. The changes in physical, organoleptic and bacteriological characteristics of clam pickles prepared using shucked meat and stored at ambient temperature are given in Table 3.

It has been observed during storage that whenever there was exposed meat in the pickle it became dried up and easily became a target for the growth of molds. This did not occur when the entire contents were covered with oil. Any loose fragment of meat adhering to the sides near the mouth of the bottle also was found to be susceptible to mold growth and hence extreme care is needed at the time of filling the pickles in bottles. Initially the texture of the meat was tough eventhough the flavour of the pickle was good. The texture of the meat became moderately soft after one month storage due to ageing. The colour slightly faded after 6 months storage and became dull after 8 months and the pickle had slight off flavour. Coliforms, streptococci, coagulase positive staptylococci and salmonella were totally absent. The TPC remained more or less same during the first 3 months and decreased slightly subsequently. The pickle kept well for 6 months in sealed bottles at room temperature.

Pickle was also prepared using blanched shucked clam meat. Blanching losses were 15 to 20% and the frying time could be reduced to 30 min. The pickle was slightly less in taste, owing to some of the flavour bearing constituents lost during blanching. However, there were no difference in the bacteriological quality and shelf life of the pickles prepared by both ways probably due to frying the meat prior to pickling.

References

AOAC (1955) *Official and Tentative Methods of Analysis*, 8th Edn., Association of Official Agricultural Chemists, Washington

Balachandran, K. K. & Unnikrishnan Nair, T. S. (1975) *Proc. Symp. Fish. Processing Industry in India*, p. 53

Difco (1971) *Microbiological and Chemical Laboratory Procedures,* 9th Edn. Difco Laboratories Inc. Detroit, Michigan.

FDA (1973) *Bacteriological Analytical Manual for Foods. Chapter XIX. Examination of Shell Fish and Shell Fish Meats. Division of Microbiology, Bureau of Foods, Food and Drug Administration, U. S. A.*

Galton, M. M., Morris, G. K. & Martin, W. T. (1968) *Salmonellae in Foods and Feeds. U. S. Dept. of Health, Education and Welfare, Atlanta, U. S. A.*

Kleiy, Van de (1951) *Biochem. Biophys, Acta,* 481

Sebastian, M. J. (1970) *Seafood Export J.* **24,** 25

Venkataraman, R. & Chari, S. T. (1951) *Ind. Jour. Med. Res.* **39,** 533

Studies on Frozen Storage of Ghol (*Pseudosciaena diacanthus*)

D. K. GARG, JOSE STEPHEN* and A. P. VALSAN

Bombay Research Centre of Central Institute of Fisheries Technology, Bombay-400 005

Investigations were carried out on the frozen storage of ghol *(Pseudosciaena diacanthus)* in the form of fillets. The results indicated that ghol fillets stored at –18°C remained in a highly acceptable condition upto 20 weeks. However, after this stage, the acceptability steeply declined.

Pseudosciaena diacanthus forms an important fishery of the Bombay coast. Rao (1963) states that at Bombay, *Pseudosciaena diacanthus*, locally called 'ghol', ranks first in off-shore sciaenid fishery forming 5 to 8% of the total trawl catch. Unlike most other sciaenids, ghol grows to an unusually large size and is esteemed as a table fish. The size of the adult fish ranges between 28 to 108 cm and weigh 1 to 12 kg. Published literature does not indicate any scientific data on the freezing and storage characteristics of ghol fllets. In view of the good export potential of frozen ghol fillets, a detailed study was carried out and results presented in this paper.

Materials and Methods

Fresh ghols weighing about 8 to 10 kg were procured from local landings at Bombay. In the laboratory they were thoroughly washed, skinned and filleted. Fillets (average thickness 5 cm, weight 200 to 250 g) were then washed with potable water, drained for 10 min, individually wrapped in polythene film, quick frozen in contact plate freezer at —40°C and then stored in a deep freezer maintained at —18°C for 24 weeks. Analysis of fillets was carried out at regular intervals of four weeks.

Moisture, total nitrogen and non-protein nitrogen were estimated by the AOAC (1960) procedure, free fatty acid by the method of Dyer & Morton (1956), total volatile nitrogen by Conway & Byrene (1933) while α-amino nitrogen was estimated by Pope & Stevens (1939) and thiobarbituric acid value was measured according to Tarladgis *et al.* (1960). Total plate count was determined by IS: 2237 (1971) procedure. The physical characteristics like colour, texture and odour were recorded immediately after thawing. For the assessment of organoleptic quality, thawed material was cooked in 2.5% solution of sodium chloride for 10 min.

Results and Discussion

The usual commercial method of dressing and filleting of the fish was followed throughout the investigation. A number of such repeated experiments indicated that the net yield of fillets ranged between 45 to 50% of the whole fish.

The results of analysis of frozen fillets are presented in Tables 1 & 2. The moisture content of the frozen and stored fillets decreased from 78.28 to 76.5% during the 24 weeks storage. This loss in moisture may be attributed to loss by way of drip as well as dehydration. Total nitrogen values decreased from 3.407 to 3.18% and non-protein nitrogen from 0.348 to 0.253%. However, total volatile nitrogen values showed a gradual increasing trend from an initial level of 13.5 to 16.6 mg/100g. Shenoy & James (1974) have recorded similar observations with respect to sardine and Kamasastri *et al.* (1967) with respect to pomfrets. The initial α-amino nitrogen content of the fish was found to be 12.10

* Present address: Central Institute of Fisheries Technology, Cochin-682 029

Table 1. *Effect of frozen storage on chemical and bacterial composition of ghol fillets*

	Storage period in weeks						
	Initial	4	8	12	16	20	24
Moisture %	78.28	78.32	78.09	77.81	76.95	76.80	76.50
Total nitrogen %	3.407	3.440	3.190	3.404	3.380	3.230	3.180
Non-protein nitrogen %	0.348	0.321	0.313	0.314	0.315	0.314	0.253
Total volatile nitrogen mg/100g	13.50	14.10	15.00	15.10	15.40	15.60	16.60
∝-Amino nitrogen mg/100g	12.10	10.63	14.28	12.69	10.92	9.80	9.20
Free fatty acid (% oleic acid)	1.90	2.81	2.93	3.41	3.72	4.77	6.79
Thiobarbituric acid value (micromoles malonaldehyde/ kg flesh)	1.50	2.00	2.50	3.00	3.75	6.00	13.25
Total plate count/g	1.90×10^{6}	1.17×10^{3}	1.28×10^{3}	1.28×10^{3}	1.87×10^{3}	4.87×10^{3}	1.4×10^{3}

Table 2. *Physical and organoleptic quality of thawed and cooked fillets*

	Storage period in weeks						
	Initial	4	8	12	16	20	24
Thawed fillets							
Colour	Very good	Good	Good	Good	Fair	Fair, slightly discoloured	Poor, pronounced discolouration
Texture	Firm	Firm	Firm	Firm	Slightly spongy	Slightly spongy	Spongy
Odour	Very good	Good	Good	Fair	Fair	Fair, slight rancid odour	Poor, high rancid odour
Cooked fillets							
Texture	Firm, dry	Firm, dry	Firm	Firm but slightly crumby	Slightly spongy	Slightly spongy	Tough and spongy
Flavour	Very good	Good	Good	Fair	Fair	Fair, no perceptible rancid flavour	Poor, rancid flavour

mg/100g. This value is relatively low compared to the values estimated by Velankar & Govindan (1958) in the case of most other marine fishes. During the storage period, the values slightly declined to 9.20 mg/100g. Free fatty acid values of the fillets increased from 1.90 to 6.79%. This increase appeared to be closely related to the increase in the

degree of spongyness of the fillets observed during the organoleptic assessment of the stored product. This corroborates with the findings of Kamasastri *et al.* (1967) with reference to silver pomfrets and Shenoy (1976) with reference to seer fillets. The increase in thiobarbituric acid value was gradual and steady and reached a level of 6 by the end of 20 weeks. After this stage, the increase was abrupt and reached a maximum of 13 during the next weeks of storage. This observation is substantially corroborated with the organoleptic observations. Total bacterial count recorded a marked fall from an initial level of 1.90×10^6 to 1.17×10^3 within a period of four weeks. After this, the values remained more or less steady.

Taking the biochemical, bacteriological and organoleptic parameters into consideration, it may be assessed that ghol fillets remained in acceptable condition upto a period of 20 weeks in frozen storage. After this, the acceptability steeply declined.

The authors are grateful to the Director, Central Institute of Fisheries Technology, Cochin for the permission to publish the paper.

References

AOAC (1960) *Official Methods of Analysis.* 9th edn. Association of Official Agricultural Chemists, Washington

Conway, B. J. & Byrene, H. (1933) *Biochem. J.* **27,** 419

Dyer, W. J. & Morton, J. L. (1956) *J. Fish. Res. Bd Can.* **13,** 129

IS: 2237 (1971) *Indian Standard. Specification* for *Frozen Prawns (Shrimps).* First Revision. Indian Standards Institution, New Delhi

Kamasastri, P. V., Doke, S. N. & Rao, D. R. (1967) *Fish. Technol.* **4,** 78

Pope, C. G. & Stevens, M. F. (1939) *Biochem. J.* **33,** 1070

Rao, K. V. S. (1963) *Indian J. Fish.* **10,** 413

Shenoy, A. V. & James, M. A. (1974) *Fish. Technol.* **11,** 67

Shenoy, A. V. (1976) *Fish. Technol.* **13,** 105

Tarladgis, B. O., Watts, B. M. & Younathan, M. T. (1960) *J. Am. Oil. Chem. Soc.* **37,** 196

Velankar, N. K. & Govindan, T. K. (1958) *Proc. Ind. Acad. Sci.* **47,** 202

Bacterial Flora of EDTA Treated Oil Sardine *(Sardinella longiceps)*, Indian Mackerel *(Rastrelliger kanagurta)* and Prawn *(Metapenaeus dobsoni)* in Ice Storage*

P. K. SURENDRAN and K. GOPAKUMAR
Central Institute of Fisheries Technology, Cochin-682 029

The native flora of fresh oil sardine and mackerel consisted mainly of *Pseudomonas* spp; *Moraxella* spp; *Acinetobacter* spp. and *Vibrio* spp. During spoilage in ice, nearly 75% of their bacterial flora belonged to *Pseudomonas* spp. alone. But Na_2 EDTA treatment reduced the proportion of *Pseudomonas* spp. considerably and the major bacterial groups at the time of spoilage were *Moraxella* spp. and *Acinetobacter* spp. In the case of fresh prawn, the native flora were constituted by *Pseudomonas* spp; *Moraxella* spp; *Acinetobacter* spp. and *Vibrio* spp. At the time of spoilage of prawn in ice, *Moraxella* spp. and *Acinetobacter* spp. predominated, together constituting 74% of the total population. Na_2 EDTA treatment did not alter significantly the spoilage flora of prawns. *Moraxella* spp. and *Acinetobacter* spp. accounted for 86% of the spoilage flora in ice storage of Na_2 EDTA treated prawns.

The most important cause of spoilage of fresh fish and prawn held in ice, is the growth of micro-organisms. The growth of micro-organisms results in development of off odours and off flavours, which are the indications of spoilage. Application of chemical preservative to slow the rate of growth of micro–organisms results in extended ice storage life for fish and prawn. Chemical preservative like ethylene diamine tetra acetic acid (EDTA) salts were reported to be effective in extending the storage life of raw fish (Levin, 1967). Boyd & Southcott (1968) found that disodium salt of EDTA (Na_2 EDTA) retarded the growth of bacteria. Pelroy & Seman (1969) found that EDTA treatment caused a shift in the predominant spoilage flora. Surendran (1980) investigated various aspects of the preservation of oil sardine, Indian mackerel and prawn with Na_2 EDTA dips and subsequent storage in ice. The effect of the Na_2 EDTA treatment on the selection of bacterial population during ice–storage of these fish and prawn is reported in this paper.

Materials and Methods

Fresh oil sardine (*Sardinella longiceps*), mackerel (*Rastrelliger kanagurta*) and prawn (*Metapenaeus dobsoni*) were procured from fishing crafts operating off Cochin and brought to the laboratory within 2 to 4 h after catch.

Disodium ethylene diamine tetra–acetate (Na_2 EDTA) solutions of 1000 p.p.m. (0.1% w/v) and 10,000 p.p.m. (1% w/v) strength were used as dip solutions. The prawn/fish were dipped in the Na_2 EDTA solutions for 10 min, drained well and packed in ordinary crushed ice, in the prawn/fish to ice ratio of 1 : 1 and stored in thermocole insulated ice boxes. In all cases, untreated prawn/fish stored in ordinary crushed ice served as the control. The samples were stored for 20–30 days and ice loss was made up by addition of crushed ice, usually on alternate days.

The samples were analysed immediately on the begining of the study and thence, after intervals of 3 to 5 days during storage. Total plate count (TPC) was determined using sea water agar (SWA). The plates were incubated at $28 \pm 2°C$ for 3 days and counts taken. Bacterial cultures were isolated from TPC plates of Na_2 EDTA treated samples and the control, during each sampling. The cultures were biochemically and morphologically characterised as described by Surendran & Gopakumar (1981). They were classified by the scheme of Surendran (1980) and Surendran & Gopakumar (1981).

* Formed part of the Ph.D thesis of the first author, approved by the University of Kerala, Trivandrum

The sensitivity of cultures to various levels of Na_2 EDTA was determined by the agar plate technique (Surendran, 1980).

Results and Discussion

1. *Flora of oil sardine*

Typical results on the pattern of change in the bacterial flora of both control and EDTA treated oil sardine during ice storage are presented in Table 1. The succession of genera during ice storage of untreated oil sardine, was almost the same as reported earlier, (Surendran & Gopakumar, 1981) in connection with the CTC storage of oil sardine. The initial flora of fresh oil sardine comprised mainly of *Pseudomonas* spp. (20%), *Moraxella* spp. (12%), *Acinetobacter* spp. (18%) and *Vibrio* spp. (28%). As the storage in ice progressed, the flora changed significantly and by the time the fish spoiled, 75% of the bacteria belonged to *Pseudomonas* spp., the rest constituted by *Moraxella* (6%), *Acinetobacter* (9%), *Vibrio* (4%), *Flavobacter/Cytophaga* (2%) and *Micrococcus* (2%). The qualitative change in the flora of EDTA treated oil sardine during ice storage was entirely different. By the beginning of the ice-storage itself, the proportion of *Pseudomonas* spp. was found to be considerably reduced. Thus after 4 days in ice, the flora of 0.1% Na_2 EDTA treated fish consisted of *Pseudomonas* (7%), *Moraxella* (21%), *Acinetobacter* (30%) and *Vibrio* (22%), while the corresponding values for 1% Na_2 EDTA treated fish were, *Pseudomonas* (6%), *Moraxella* (18%), *Acinetobacter* (31%) and *Vibrio* (26%). However, as the number of days of storage in ice increased, the *Pseudomonas* spp. were found to recover from the initial fall. On the 24th day in ice, 20% of the flora of 0.1% Na_2 EDTA treated oil sardine and 18% of the flora of 1% Na_2 EDTA treated oil sardine, were composed of *Pseudomonas* spp. The other prominant groups were *Moraxella* and *Acinetobacter* spp., which together constituted 63% of the flora of the 0.1% Na_2 EDTA treated sample and 72% of the 1% Na_2 EDTA treated sample. *Vibrio* spp. diminished to 6% of the total.

The pattern of change in the percentage of gelatin liquefiers in the control and treated samples were similar; however, at the time of spoilage, 78% of the flora of the control

Table 1. *Pattern of change in the bacterial flora of untreated and EDTA treated oil sardine during ice storage*

	Percentage of micro-organisms at different intervals									
	Ordinary ice stored				Dip in 0.1% Na_2 EDTA and ordinary ice stored			Dip in 1% Na_2 EDTA and ordinary ice stored		
Days	0	4	10	24	4	10	24	4	10	24
Pseudomonas	20	21	34	75	7	12	20	6	12	18
Moraxella	12	17	14	6	21	20	26	18	24	30
Acinetobacter	18	24	22	9	30	34	37	31	38	42
Vibrio	28	18	10	4	22	18	8	26	16	6
Flavobacter/Cytophaga	4	5	4	2	5	4	3	6	3	2
Micrococcus	7	6	4	2	7	6	4	4	5	0
Others	11	9	12	2	8	6	2	9	2	2
Gelatin liquefiers	81	22	30	78	21	26	65	30	37	70
Putrefiers (fish media)	14	17	24	61	22	20	46	12	18	38
Capable of growth at 0°C	22	69	80	93	54	78	86	46	68	90
Sensitivity to 1% Na_2 EDTA	30	27	42	62	24	22	19	26	18	12
No. of cultures identified	65	62	51	56	40	51	63	70	59	52

sample were gelatin liquefiers, while only 65 to 70% of the flora of the treated samples were capable of gelatin hydrolysis. The succession of the putrefiers during ice storage seemed to be significantly different between the control and the EDTA treated fish. While 61% of the untreated oil sardine at the time of spoilage in ice, were putrefiers, only 46% and 38% of the flora of 0.1% Na_2 EDTA treated and 1% Na_2 EDTA treated fish were respectively putrefiers. This marked difference in the proportion of putrefying bacteria was evidently a reflection of the qualitative difference in the spoilage flora of the control and the treated samples.

It can also be noted from Table 1 that EDTA sensitivity of the flora of the treated fish decreased with increase in storage period. Thus only 19% of the flora of the 0.1% Na_2 EDTA treated sample and 12% of the flora of 1% Na_2 EDTA treated sample after 24 days in ice, were sensitive to 1% Na_2 EDTA, while 62% of the flora of the untreated oil sardine, was sensitive to 1% Na_2 EDTA.

2. *Flora of mackerel*

Table 2 gives typical results on the qualitative changes in the flora during ice storage of untreated and EDTA treated Indian mackerel. A comparison of this data with those presented in Table 1 shows that, the pattern of change in the flora of mackerel was almost similar to that of the flora of oil sardine, similarly treated and stored. Physiological group-wise also, similar patterns were observed.

In the case of both oil sardine and mackerel, EDTA treatment has brought about a qualitative change in the spoilage flora during ice storage of the fish. While, the dominant flora, of the untreated control samples at the time of spoilage in ice, were *Pseudomonas* spp., constituting 75 to 80% of the total flora, the major flora of the spoiling EDTA treated fish were the *Moraxella-Acinetobacter* group, forming 62% to 86% of the total, the *Pseudomonas* spp. accounting for only 8 to 17%. This significant difference in the flora is reflected in the trimethyl amine nitrogen (TMAN) values of the control and the EDTA treated samples, as well as in the percentage of putrefiers in the flora at the time of spoilage of the fish.

Pelroy & Seman (1969) have made similar observations in the qualitative changes of the bacterial flora of untreated and EDTA treated petrale sole and ocean

Table 2. *Pattern of change in the bacterial flora of untreated and EDTA treated mackerel during ice storage*

	Percentage of micro-organisms at different intervals									
	Ordinary ice stored				Dip in 0.1% Na_2 EDTA and ordinary ice stored			Dip in 1% Na_2 EDTA and ordinary ice stored		
Days	0	4	12	24	4	12	24	4	12	24
Pseudomonas	10	14	38	81	4	16	21	6	12	17
Moraxella	18	21	11	7	24	20	32	22	26	29
Acinetobacter	26	24	18	6	27	31	38	24	30	33
Vibrio	32	21	16	4	20	12	6	28	14	5
Flavobacter/Cytophaga	5	6	4	0	3	4	1	5	5	2
Micrococcus	5	7	6	1	4	3	0	4	3	2
Others	4	7	7	1	8	14	2	11	10	12
Gelatin liquefiers	82	20	31	90	16	37	68	21	29	71
Putrefiers (fish media)	14	19	30	52	11	24	47	9	18	35
Capable of growth at 0°C	7	42	70	91	32	65	84	36	67	86
Sensitivity to 1% Na_2 EDTA	21	24	36	65	28	22	20	24	17	14
No. of cultures identified	70	55	48	62	61	58	64	47	54	59

Table 3. *Pattern of change in the bacterial flora of untreated and EDTA treated prawns (M. dobsoni) during ice storage*

	Percentage of micro-organisms at different intervals									
	Ordinary ice stored				Dip in 0.1% Na_2 EDTA and ordinary ice stored			Dip in 1% Na_2 EDTA and ordinary ice stored		
Days	0	7	12	25	7	12	25	7	12	25
Pseudomonas	10	14	15	19	6	8	12	4	8	8
Moraxella	22	27	36	44	28	30	40	30	42	50
Acinetobacter	16	18	27	30	24	28	28	26	32	36
Vibrio	16	12	8	2	18	12	6	22	10	4
Flavobacter/Cytophaga	7	6	4	0	5	4	2	4	2	0
Micrococcus	8	5	2	2	7	3	2	8	2	2
Others	21	18	8	3	12	15	10	6	4	0
Gelatin liquefiers	68	30	45	90	24	36	70	20	42	60
Putrefiers (fish media)	10	18	28	40	20	20	38	18	22	30
Capable of growth at 1°C	12	50	68	86	40	72	90	50	68	94
Sensitivity to 1% Na_2 EDTA	22	20	26	28	24	20	20	26	18	14
No. of cultures identified	60	52	56	62	48	61	53	65	52	61

perch fillets stored at 0.5°C. While 64% of the flora of the control samples after 8 days of storage was *Pseudomonas* spp., only 4% of the flora of EDTA treated fillets was constituted by *Pseudomonas* spp. and 83% was comprised of by *Achromobacter* spp.

Miyauchi *et al.* (1966) have shown that *Pseudomonas* spp. are the source of trimethyl amine (TMA) production in spoiling fish. Hence, the higher values of TMA in the untreated spoiling fish—both oil sardine and mackerel were due to the higher proportion of *Pseudomonas* spp. in the flora at the time of spoilage. Similarly, the lower percentage of *Pseudomonas* spp. in EDTA treated fish accounted for the lower TMA values in EDTA treated fish.

The findings reported here are in full agreement with the observations made by Pelroy & Seman (1969) in the case of fillets of ocean perch and petrale sole from Canadian waters, that the increased shelf life of the EDTA treated fish is due to the inhibition of growth and concomitant metabolic activity of *Pseudomonas* spp.

3. Flora of prawn (M. dobsoni)

The pattern of qualitative changes in the flora of untreated and EDTA treated prawn *(M. dobsoni)* during ice storage, is presented in Table 3. The flora of spoiling untreated prawn comprised mainly of *Moraxella-Acinetobacter* group, together constituting 74% and the *Pseudomonas* formed 19% of the total flora. Since EDTA is found to eliminate selectively the *Pseudomonas* groups, EDTA treatment did not essentially bring about a significant qualitative change in the succession of the flora of prawns during ice-storage. But, the proportion of *Pseudomonas* spp. was lower compared with the untreated control. At the time of spoilage of 1% Na_2 EDTA treated prawns, 86% of the flora was composed of *Moraxella-Acinetobacter* group. *Pseudomonas* spp. constituted only 8% of the flora.

Much difference in the changes of biochemical groups were not observed between the untreated and EDTA treated prawn during storage. While 90% of the flora of the untreated prawn on 25th day of ice

Table 4. *Na_2 EDTA sensitivity of bacterial cultures isolated from Na_2 EDTA treated oil sardine*

Bacterial genus	Cultures from sardine before treatment				Cultures from sardine dipped in 1% Na_2 EDTA and stored in ice for 8 days				Cultures from sardine dipped in 1% Na_2 EDTA and stored in ice for 25 days			
		Percentage of cultures sensitive to the given Na_2 EDTA levels										
	No. of cultures	Na_2 EDTA 0.1%	1%	2%	No. of cultures	Na_2 EDTA 0.1%	1%	2%	No. of cultures	Na_2 EDTA 0.1%	1%	2%
Pseudomonas	40	30	75	100	45	22	60	80	52	10	40	70
Moraxella	56	12	20	26	48	12	14	22	40	10	15	15
Acinetobacter	48	8	14	22	54	6	14	26	49	2	16	22
Vibrio	64	4	12	16	72	5	10	12	60	8	8	10
Micrococcus	30	9	14	27	25	8	16	20	40	5	10	18
Flavobacter/Cytophaga	18	10	25	35	12	16	16	24	10	0	20	20
Alcaligenes	6	0	16	32	10	0	10	30	6	0	16	16
Arthrobacter	10	10	20	40	4	0	25	25	8	0	12	25

storage, was gelatin liquefiers, the corresponding percentage in the 0.1% Na_2 EDTA treated and 1% Na_2 EDTA treated prawn were 70% and 60% respectively. The percentage of putrefiers in the flora of prawn on the 25th day of ice storage was 40% in the control and 38% and 30% respectively in the 0.1% Na_2EDTA treated and 1% Na_2EDTA treated prawn. The proportion of EDTA sensitive flora decreased with increase in the number of days of ice storage in the case of EDTA treated samples, while in the control samples, the EDTA sensitive fraction remained more or less in the same range.

Thus it is evident that EDTA treatment did not bring about a significant change in the spoilage flora of prawn. As in the control, the major flora at the time of spoilage were the *Moraxella-Acinetobacter* group, the proportion of *Pseudomonas* being less. But, in the control 19% of the spoilage flora was *Pseudomonas* spp. while only 8 to 12% of the spoilage flora of EDTA treated prawns were *Pseudomonas*. Since *Pseudomonas* spp. are known to be the major source of TMA (Miyauchi *et al.*, 1966), in spoiling fish, the low values in TMAN in the EDTA treated samples might be explained as due to low proportions of *Pseudomonas* in them. But, the very low values of TMAN in the treated samples as compared with the control are not so easily explained. For example, by 25th day of ice storage, the TMAN values in the control and 1% Na_2 EDTA treated prawns were 22.86 and 4.92 mg/100g respectively (Surendran, 1980). The corresponding proportions of *Pseudomonas* spp. in the total flora were respectively 19% and 8%. While the ratio of the number of *Pseudomonas* in the treated sample, to that in the control is 8:19 (42%), the corresponding ratio of the TMAN values is 4.92:22.86 (21.5%). TMAN is not exclusively produced by *Pseudomonas* alone, but members of the *Moraxella-Acinetobacter* group and *Vibrio* spp. also produce TMAN; but their contribution is not appreciable in the case of spoilage at low temperature. As major producer of TMA in spoiling fish is *Pseudomonas* spp. itself (Miyauchi *et al.*, 1966) it can be concluded that even among the *Pseudomonas* spp; the TMA producers were more selectively suppressed by EDTA. However, further investigations are required to substantiate this.

4. EDTA sensitivity of cultures from EDTA treated fish and prawn

The sensitivity of cultures towards EDTA was found to undergo considerable changes during the ice storage of EDTA treated fish and prawn. In Table 4, are presented typical results of EDTA sensitivity of bacterial cultures isolated from EDTA treated oil sardine held in ice storage.

In the case of cultures isolated from oil-sardine just before EDTA treatment, 75% of *Pseudomonas* strains, 20% of *Moraxella* strains, 25% of *Flavobacter/Cytophaga* strains, 12% of *Vibrio* strains and 14% of *Acinetobacter* strains were sensitive to 1% Na_2 EDTA. The sensitivity of cultures isolated from EDTA treated fish was found to decrease as the number of days of storage increased. Thus, after 8 days of storage, only 60% of *Pseudomonas* strains, 14% each of *Moraxella* and *Acinetobacter* strains, and 10% of *Vibrio* strains were sensitive to 1% Na_2 EDTA. In the case of strains isolated from treated oil sardine held in ice-storage for 25 days, only 40% of *Pseudomonas* cultures was sensitive to 1% Na_2 EDTA. Thus, it is evident that, although there was a general decrease in the EDTA sensitivity for cultures isolated from treated fish, this decrease was more pronounced in the case of *Pseudomonas* spp. Since, the enhancement of shelf life by EDTA treatment is due to the selective inhibition of growth and concomitant metabolic activity of *Pseudomonas* spp. the development of insensitive *Pseudomonas* strains is of great economic importance, so far as the use of EDTA for fish preservation is concerned.

The authors express their sincere gratitude to the Director, Central Institute of Fisheries Technology, Cochin-682 029 for the facilities provided for this investigation. They are also thankful to the Scientist-in-Charge, Microbiology Division, Central Institute of Fisheries Technology for his co-operation.

References

Boyd, J. W. & Southcott, B. A. (1968) *J. Fish. Res. Bd Can.* **25**, 1753

Levin, R. E. (1967) *J. Milk Fd Technol.* **30,** 277

Miyauchi, D. T., Spinelli, J. & Pelroy, G. (1966) *U. S. At. Energy. Comm. Div. Isotop. Develop. Rept. TID*-23825, *Isotopes-Ind. Technol.* TID-4500

Pelroy, G. A. & Seman, J. P. (Jr.) (1969) *J. Fish. Res. Bd Can.* **26,** 651

Surendran, P. K. (1980) *Chemical Preservatives in Relation to Control of Microbial Changes in Fishery Products.* Ph.D. Thesis; University of Kerala, Trivandrum

Surendran, P. K. & Gopakumar, K. (1981) *Fish. Technol.* **18,** 133

Fish. Technol. (1982) **19**, 41-43

Pickled Products from Green Mussel

V. MURALEEDHARAN, K. GEORGE JOSEPH and K. DEVADASAN*

Calicut Research Centre of Central Institute of Fisheries Technology, Calicut-673 005

Methods of preparing different types of delicious ready to serve pickled products from green mussel *(Perna viridis)* and a comparative study of their storage characteristics are reported. Of the three types of products, namely, dried and pickled, fried and pickled and light smoked and pickled, the last one had the best shelf life. The optimum conditions of drying and smoking for preparing such type of pickles are also reported.

Sizeable quantities of green mussel *(Perna viridis)* are landed along the Malabar coast, especially from Calicut to north. Presently it is fetching only a very poor return to the fishermen, as it is consumed by the local population only. Very few attempts have been made to utilize them properly. Methods have been worked out at the Central Institute of Fisheries Technology for producing attractive canned and cured products from green mussels (Balachandran & Nair, 1975; Muraleedharan *et al.*, 1979). Production of ready to serve pickled products from mussels appears to be the best method for its economic utilisation. Such a product will have a very good internal market as a table delicacy which in turn fetch better return to the fishermen. Different pickled products, were thus prepared and their storage life are reported.

Materials and Methods

Green mussels, collected from the rocky Korapuzha estuary, about 10 km from Calicut, were brought to the laboratory in live condition and washed well in running water. They were then placed in sand free water for a day, transferred to fresh chlorinated water (5 p.p.m. available chlorine) for 2 h which resulted in the complete expulsion of sand from the stomach of mussels. The meat was then shucked alive and analysed for moisture, fat, protein, ash, acid insolubles, calcium and phosphorus by the methods of AOAC (1960) and glycogen was estimated by the method of Van de Kleiy (1951). The shucked meat was blanched in 5% brine for 5 min (750 ml brine for kilogram of meat) and pickled in three lots as follows.

1. *Dried and pickled mussels*

The mussel meat was dried over clean rust free wire trays in sun to a moisture level of 40%. 500 g dried meat was then heated with gingelly oil to light brown colour. This meat was pickled using condiments as given below.

Partially dried, oil heated meat	500 g
Green chillies (sliced)	25 g
Fresh ginger (sliced)	50 g
Crushed garlic	25 g
Chilly powder	50 g
Turmeric powder	5 g
Refined salt	25 g
Skinned mustard	25 g

The blended condiments were gently heated in gingelly oil and transferred to partially dried meat, mixed well in a dry container, 100 ml of vinegar added and the container closed air tight after pouring some oil over the top layer.

2. *Fried and pickled mussels*

The blanched meat (moisture 60%) was directly fried in gingelly oil (without any pre-drying) until light brown in colour, pickled and stored in containers as described above.

* Present Address: Central Institute of Fisheries Technology, Cochin-682 029

3. *Smoked and pickled mussels*

Another portion of the blanched meat was partially sun dried to 50% moisture and smoked in vertical smoke kiln at 85–90° C for 30 min and moisture brought down to a level of 35%. The light smoked meat was then pickled and kept in air tight dry containers as in the earlier cases but only 50 ml vinegar was used. The products were periodically analysed for shelf life.

Results and Discussion

Table 1 gives the proximate composition of fresh mussel meat. Keeping the live mussels in water for a day followed by 2 h in chlorinated water facilitated to remove the sand from the stomach. Manual removal of sand from stomach was time consuming which also resulted in distortion of meat.

The recipe employed can be suitably altered to suit individual taste. Of the various oils, coconut oil gave a good product, but it turned rancid easily. Mustard oil prevented mould growth effectively. But mustard oil taste may not be very much relished and hence gingelly oil was preferred. Use of skinned mustards along with gingelly oil was found sufficient to protect the pickle from mould growth without affecting the taste and flavour. For those who relish mustard oil, mustard oil can be used.

In the dried and pickled product the

Table 1. *Proximate composition of mussel meat*

Moisture %	82.950
Protein %	8.940
Fat %	1.950
Ash %	1.620
Calcium %	0.852
Phosphorus %	0.325
Acid insolubles %	0.058
Glycogen %	3.910

Table 2. *Storage characteristics of mussel pickles*

Storage period Days	Fried and pickled	Dried and pickled	Smoked and pickled
30	Good	Good	Good
60	Good	Good	Good
90	Good	Good	Slight smoky flavour
120	Meat softened, acceptable	Meat slightly softened, acceptable	Very slight smoky flavour, acceptable
150	Meat softened, slight off odour, acceptable	Meat softened, slight off odour, acceptable	Very slight, smoky flavour, acceptable
180	Meat comes off easily, stray patches of fungus on top layer, acceptable	Meat comes off easily, fungus on top layer, off odour, not acceptable	Smoky flavour decreased, stray patches of fungus on top layer, acceptable
200	Intense off odour, meat darkened, fungus present, not acceptable	Spoiled	Smoky flavour further decreased, slight off odour, stray patches of fungus, acceptable

drying should be stopped at 40% moisture. Excessive drying will impart hard texture and take more time to mature the pickle. In smoked and pickled products partial drying was essential for uniform and proper uptake of smoke. Excessive drying and smoking are to be avoided. Smoking for 30 min is found sufficient to impart an appealing flavour.

The storage characteristics of the products are presented in Table 2. The fried and pickled product was found to "mature" within 2 days in the pickle whereas the dried and pickled product took 3 days and the smoked and pickled one took 4 days to mature. All the products could be stored till 6 months. Comparatively, the smoked and pickled product had a slightly better shelf life and was acceptable even after 200 days of storage, though the smoky flavour was found to be reduced. The dried and pickled one softened and disintegrated by then. Stray patches of fungus were also observed on the top layer. Similar characteristics were also noticed in the fried and pickled product after six months.

The authors are thankful to the late Shri G. K. Kuriyan, Director, Central Institute of Fisheries Technology, Cochin for permission to publish the paper.

References

AOAC (1960) *Official Methods of Analysis*. 9th edn. Association of Official Agricultural Chemists, Washington

Balachandran, K. K. & Unnikrishnan Nair, T. S. (1975) *Proc. Symp. Fish Processing Ind. India,* CFTRI, Mysore

Muraleedharan, V., George Joseph, K. & Unnikrishnan Nair, T. S. (1979) *Fish. Technol.* **16,** 30

Van de Kleiy, B. J. (1951) *Biochem et Biophys. Acta,* 481

Ice Storage Studies of Kati (*Pellona* sp.)

D. K. GARG and JOSE STEPHEN*

Bombay Research Centre of Central Institute of Fisheries Technology, Bombay-400 005

Studies were carried out on the effect of ice storage on the composition of kati (*Pellona* sp.). On the basis of biochemical, bacteriological and organoleptic evaluations, it was observed that kati can be stored in ice for a period of 9 days without appreciable loss in overall quality.

Large amounts of kati (*Pellona* sp.) are landed every year on the north-west coast of India. This also forms an important food fish of this region, proper preservation of which is essential both after catch and during transportation and distribution. Though ice storage studies on mackerel and sardine (Madhavan *et al.*, 1970), pomfrets (Kamasastri *et al.*, 1967), mussels, clams and crabs (Chinnamma *et al.*, 1970) and perch (Solanki *et al.*, 1977) have been reported, there appears to be a paucity of data on the preservation of some of these fishes of the north-west region. The present investigation was therefore undertaken to study the amenability of kati to ice storage.

Materials and Methods

Fresh kati of uniform size (2–4 nos. per kg) were procured from local landings at Bombay and immediately brought to the laboratory in crushed ice. Fish were thoroughly washed and stored in insulated box provided with a raised perforated platform and mixed with ice in 1 : 1 ratio. Ice was replenished for the quantity melted during storage. The insulated box was also provided with an outlet to drain out water so that the fish, throughout the investigation, was never in contact with water. Samples were drawn and analysed every alternate day for physical, organoleptic and biochemical qualities. Moisture, total nitrogen and non-protein nitrogen were determined according to AOAC (1960), total volatile nitrogen by the procedure of Conway & Byrene (1933) and α-amino nitrogen in accordance with the procedure of Pope & Stevens (1939), free fatty acids by the method of Dyer & Morton (1956) and thiobarbituric acid value according to the method of Tarladgis *et al.* (1960). Total bacterial count was determined as

Table 1. *Biochemical and bacterial changes during ice storage of kati*

Storage period (days)	0	3	5	7	9	11	13
Moisture %	76.41	77.11	77.25	77.21	77.03	78.69	78.85
Total nitrogen %	3.38	3.08	3.08	2.97	2.89	2.88	2.77
Non-protein nitrogen %	0.333	0.312	0.291	0.265	0.283	0.268	0.238
Total volatile nitrogen mg/100 g	11.70	11.90	12.25	12.85	14.70	15.40	16.52
α-Amino nitrogen mg/100 g	18.20	17.92	15.82	6.02	8.12	6.19	5.32
Free fatty acid as oleic acid %	0.59	0.62	0.81	0.96	1.09	1.29	1.65
Thiobarbituric acid (micromoles malonaldehyde per kg flesh)	1.50	2.25	4.87	6.37	8.25	11.25	15.00
Total bacterial count/g	4.18×10^4	1.65×10^3	1.15×10^3	1.09×10^4	2.15×10^4	5.55×10^4	5.45×10^5

* Present address: Central Institute of Fisheries Technology, Cochin-682 029

per IS : 2237 (1971). Organoleptic assessment was carried out after cooking the meat in 2.5% solution of sodium chloride for 10 min.

Results and Discussion

The biochemical and bacterial changes taking place during ice storage of kati are presented in Table 1. The moisture content of the stored fish increased from 76.41 to 78.85% on the 13th day of storage. Total nitrogen content decreased from an initial value of 3.38 to 2.77% and non-protein nitrogen from 0.333 to 0.238%. This decrease may be attributed to leaching during ice storage. Shenoy & James (1974) have also obtained a gradual decreasing

Table 2. *Changes in physical and organoleptic quality during ice storage of kati*

Storage period (days)	0	3	5	7	9	11	13
Components							
Eyes	Convex bright shining	Bright convex	Flat but clear	Flat and slightly cloudy	Flat and cloudy	Sunken opaque	Sunken opaque
Gills	Bright red without slime	Bright red	Red	Red	Pale red with slight slime	Brown with slime	Brown with slime
Colour	Bright silvery white	Bright	Decrease in bright silvery colour	Dull white	Dull white	Dull	Dull with scales getting very loose
Texture	Firm	Firm	Firm	Slightly firm leaving no thumb impression	Slightly soft	Soft	Very soft leaving thumb impression
Odour	Fresh fish odour	Fresh fish odour	Fresh fish odour	Neutral odour	Neutral with slightly rancid	Stale and slightly rancid	Stale and putrid smell
Cooked characteristics							
Texture	Firm; dry	Firm; dry	Firm	Firm	Slightly soft	Soft breaks easily	Soft and sticky
Flavour	Very good	Good	Good	Fair	Slightly rancid	Stale and rancid	Stale and off
Taste	Very good	Good	Good	Fair	Fair	Fair but slight after taste	Poor and bitter after taste

pattern for total nitrogen and non-protein nitrogen values during ice storage of seer. α-amino nitrogen values registered a decline with progressive ice storage from an initial value of 18.20 to 5.32 mg/100g. on the 13th day. This may also be due to leaching. This decrease is marked with the loss in flavour of the material. Solanki *et al.* (1977) have reported similar trend while working on the ice storage characteristics of perch. Total volatile nitrogen steadily increased during ice storage but the values were not very high. Free fatty acids, as a result of lipid hydrolysis, increased from 0.59 to 1.65%. These observations are in conformity with those of Madhavan *et al.* (1970) with reference to ice storage of mackerel and sardine. Thiobarbituric acid value increased from 1.5 to 15 on the 13th day resulting in strong rancid odours. Total bacterial count, which was 4.18 x 10^4 initially, decreased to 1.15 x 10^3 by the 5th day. Thereafter, it gradually increased to 5.45 x 10^5 by 13th day. The fall in bacterial count during initial stages of ice storage may be due to the washing out of surface slime together with bacteria along with ice-melt water. Gradual icrease in bacterial count after the 5th day may be due to the proliferation of psychrophilic bacterial flora.

Physical and organoleptic changes taking place in ice stored kati are presented in Table 2. Texture of the fish was firm upto 7 days. Beyond this period it indicated perceptible sign of softening and by the 13th day it became very soft. At this stage, the scales were very loose and easily separable. The fish also emitted off odour. Texture, flavour and odour of the cooked material were poor after 9th day and the fish was unfit for consumption on the 13th day.

Results presented above indicate that kati was in fairly acceptable condition till 9th day. On the 11th day, the acceptability was on the border line and on the 13th day it was highly spoiled and unacceptable.

The authors are grateful to the Director, Central Institute of Fisheries Technology, Cochin for permission to publish the paper.

References

AOAC (1960) *Official Methods of Analysis.* 9th edn. Association of Official Agricultural Chemists, Washington

Conway, B.J. & Byrene, H. (1933) *Biochem. J.* **27,** 419

Chinnamma, P.L., Chaudhuri, D.R. & Pillai, V.K. (1970) *Fish. Technol.* **7,** 137

Dyer, W.J. & Morton, J.L. (1956) *J. Fish. Res. Bd Can.* **13,** 129

IS : 2237, (1971) *Indian Standard, Specification for Frozen Prawns (Shrimps).* Indian Standards Institution, New Delhi

Kamasastri, P.V., Rao, D.R. & Ghadi, S.V. (1967) *Fish. Technol.* **4,** 71

Madhavan, P., Balachandran, K.K. & Chaudhuri, D.R. (1970) *Fish. Technol.* 7, 67

Pope, C.G. & Stevens, M.F. (1939) *Biochem. J.* **33,** 1070

Shenoy, A.V. & James, M.A. (1974) *Fish. Technol.* **11,** 67

Solanki, K.K., Radhakrishnan, A.G., Jose Joseph & Venkataraman, R. (1977) *Fish. Technol.* **14,** 119

Tarladgis, B.O., Watts, B.M. & Younathan, M.T. (1960) *J. Am. Oil. Chem. Soc.* **37,** 196

Fish. Technol. (1982) **19**, 49-53

Investigations on the Number of Trials Required for Statistical Comparison of Fishing Gears

A. K. KESAVAN NAIR

Central Institute of Fisheries Technology, Cochin-682 029

The number of fishing trials required for comparing the efficiency of fishing gears was investigated. A unique solution to this problem did not appear to exist because of the heterogeneity of the experimental material. Sequential experimentation and analysis have been found to be a practical approach to this problem. By this, the experiment can be terminated utmost after 35 days' fishing for catches with standard error per unit as per cent of the mean about 30% or less(after logarithmic transformation). For data with mean catches less than 1.5 kg analysis of variance approach does not appear to be meaningful.

To compare the efficiency of fishing gears, one of the statistical designs used is the randomised block design where a block is constituted by consecutive hauls made in the same area on the same day. The fishing gears tested for their relative efficiencies form the treatments. For economy and to get quick results, the optimum number of trials are useful. Solution on the number of trials require information on the estimate of variance ($\bar{\sigma}$) in the population and a specification of the largest confidence interval to be tolerated or the smallest mean difference. Simple estimate of the sample size as well as estimates specifying the probability of success are given by Panse & Sukhatme (1957), Snedecor (1961), Cochran & Cox (1963) and Kempthorne (1967). Information on the variance is normally obtained from a previous experiment or from a knowledge of the range. Panse & Sukhatme (1957) have stated that in the absence of information on the variability, the number of replications should be sufficient to ensure at least about 12 degrees of freedom (d.f) for error. Tables on the number of replications required for a given probability of obtaining a significant result have been given by Cochran & Cox (1963). These numbers correspond to a range of 2 to 20 in the standard error per unit expressed as per cent of the mean. For large values of standard error as per cent of the mean, the number of replicates are to be worked out. Formula to work out the number of blocks relevant to randomised block experiments has been given in Snedecor (1961). Results of an investigation conducted to estimate the optimum number of trials are reported in this communication.

Materials and Methods

The present investigation on the number of replicates is an empirical study using three sets of data. The data were arranged sequentially for 10, 15, 20, 25, 30 and 35 days. At each stage the number of blocks were estimated using the formula.

$$b = \frac{(Qa,\ f)^2\ (s^2_o)\ Ff,\ f_o}{\delta^2} \quad \ldots\ldots\ldots\ldots 1$$

given by Snedecor (1961). Here, 'a' is the number of treatments tested, f = (a–1) (b–1) corresponding to a large value of b, S_o, the standard error per unit (an estimate of $\bar{\sigma}$), f_o, d.f. corresponding to the mean square S_o^2 and δ, the least population difference in the means, the proposed experiment is expected to detect with p = 0.75. The values of Qa, f and Ff, f_o orginally tabulated by May (1952) and Merrington & Thompson (1943) respectively were taken from Snedecor (1961). For a given number of blocks b, the lowest differences in the means which the experiment would detect, were worked out from,

$$\delta = \frac{Qa,\ f\ (s_o)\ \sqrt{Ff,\ f_o}}{\sqrt{b}} \quad \ldots\ldots\ldots 2$$

The variation in the estimates of parameters when based on increasing number of blocks and also the relationship between some estimated parameters were studied graphically.

Results and Discussion

The mean (m), S_o^2, standard error per unit as percent of the mean ($\frac{S_o}{m} \times 100$) and b, estimated from consecutive trials of 10, 15, 20, 25, 30 and 35 days (using MICRO 2200 of Hindustan Computers) after logarithmic transformation for the three sets are given in Table 1. The b's were estimated for detecting 20% or more difference in the means (δ=20% of the mean) with p = 0.75. The standard error per unit as per cent of the mean ranged between 17 to 40% for the first set, 14 to 24% for the second and 53 to 74% for the third. Thus the experimental material appeared to be heterogeneous. From its relationship with the number of blocks used to estimate, the estimated number of blocks were found to be more stable and realistic for sets 1

Table 1. *Showing the mean, standard error per unit, standard error per unit as percent of the mean and b, computed from* 10, 15, 20, 25, 30 *and* 35 *days of fishing trials.*

A. Set 1

No. of days	Mean (m)	Standard error per unit (So)	Standard error per unit as per cent of the mean (So/m x 100)	b	Significance of difference between treatments
10	0.2756	0.10984	39.8	62	NS
15	0.4063	0.09561	23.5	21	*
20	0.5435	0.09103	16.7	10	*
25	0.6293	0.18425	29.3	30	NS
30	0.6699	0.20201	30.1	32	NS
35	0.7475	0.20059	26.8	25	NS
B. Set 2					
10	0.4084	0.09767	23.9	23	*
15	0.5401	0.09735	18.0	12	*
20	0.6505	0.08962	13.8	7	**
25	0.6889	0.11922	17.3	11	**
30	0.7845	0.12506	15.9	9	*
35	0.8471	0.14996	17.7	11	**
C. Set 3					
10	0.3008	0.17570	58.4	133	*
15	0.2880	0.15193	52.7	103	**
20	0.2578	0.14743	57.2	116	*** (P< 0.1)
25	0.2375	0.13764	57.9	117	*** (P< 0.1)
30	0.2285	0.16174	70.8	173	*** (P< 0.1)
35	0.2391	0.17717	74.1	188	*** (P< 0.1)

NS = Not significant, * = Significant at 5% level,
** = Significant at 1% level, *** = Significant at 0.1% level

and 2 (Fig. 1). Set 3, for which the estimated numbers of blocks are larger, the estimates do not stabilize but increase

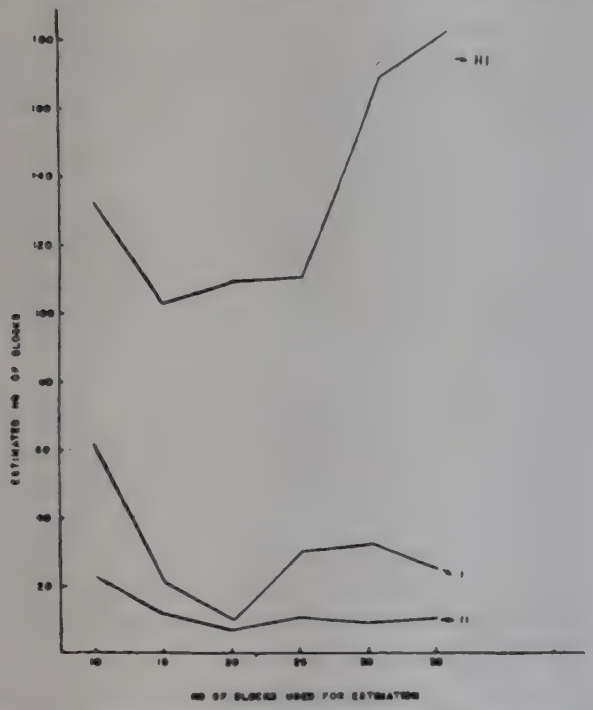


Fig. 1. Relation between estimated number of blocks and number of blocks used for estimation

with increasing number of blocks from which the estimates were made. Thus the large sample property of estimates was not found to be satisfied for this set within the available range of values. This is because

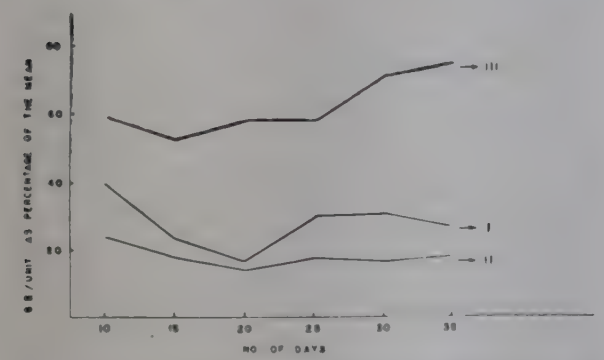


Fig. 2. Relation between standard error per unit as percentage of the mean and number of days

the estimated number of blocks increases with increase in the standard error per unit and as found from Fig. 2, the estimated standard error as per cent of the mean increases when the number of blocks (days),

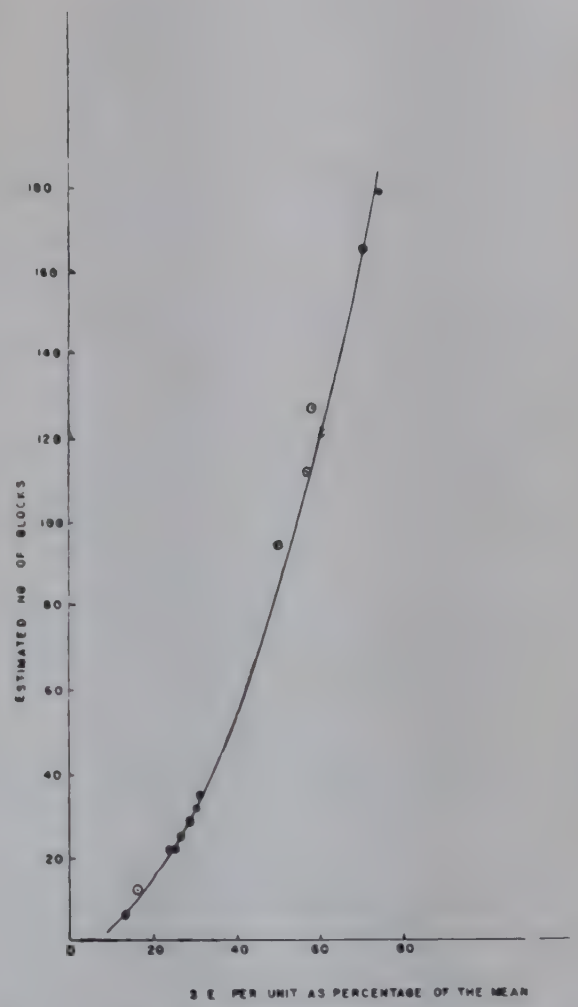


Fig. 3. Relation between estimated number of blocks and standard error per unit as percentage of the mean

from which this is estimated, increases. The standard error per unit as per cent of the mean are also relatively larger (above 50%) for this set. To know how much larger the estimated number of blocks should be for larger increase in standard error per unit as per cent of the mean, figure 3 is employed. A common curve appears to adequately represent the three sets of data. The figure shows that for standard error larger than about 30% of the mean large number of blocks are required. For such sets of data (as in set 3), the estimation of number of blocks do not seem to be useful, because experiments requiring very large number of replications are not desirable from practical and economic points of view. Such data calls for other method of handling. As found from Fig. 4, larger standard errors per unit as per cent

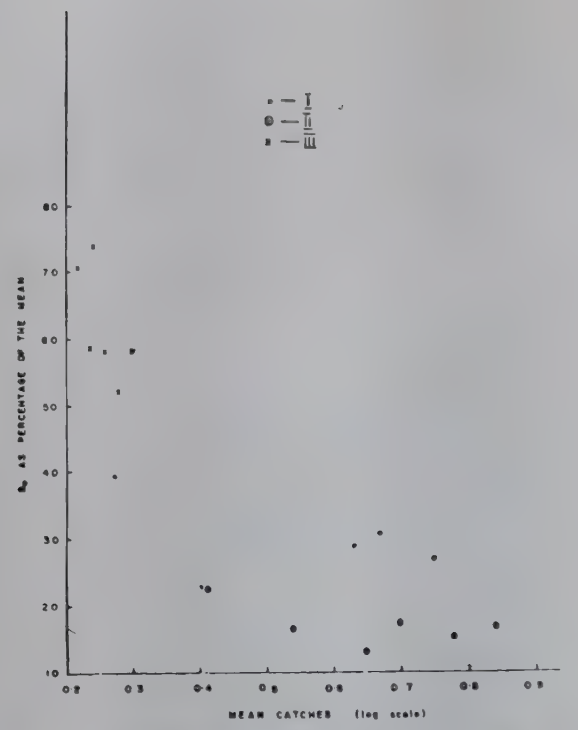


Fig. 4. Relationship between mean catch and S_o as per cent of the mean

of the mean are associated with smaller mean catches, the rate of increase in the former being rapid for decrease in the latter below a certain level. For instance, for the mean catch less than 0.4 (1.5 kg in original scale), the standard error as per cent goes above 40. Thus, when the catch is very poor, standard error as per cent of the mean and consequently the number of blocks required becomes very large making the analysis of variance less meaningful. The fact that when the availability of fish in the exploited area is very poor, catches will not reflect the efficiency of gears supports this conclusion.

With variations in the number of blocks, changes in the level of significance of the difference in treatment effects could be observed (Table 1). For set 3, though the significance level was very high ($P < 0.1$), the δ – value computed from equation (2) for 35 blocks was 46.1% of the mean showing that the experiment would detect only treatment effects as large as 46.1%. But the corresponding δ – values for sets 1 and 2 were 16.7 and 11.0% of the mean respectively, which agree with the originally set δ – value of 20% or less. These results also support the observations made in the preceding paragraph.

In conclusion, as a practical procedure, the accumulated data can be analysed sequentially at the ends of 10, 15, 20.....days and depending on the standard error as per cent of the mean, a decision on the number of trials can be made with 35 days' trial. If the standard error per unit as per cent of the mean stabilizes at about 30% or below, the experiment can be stopped and the decision at this stage can be taken as conclusive. The population which gives rise to such sets of data is probably less affected by fluctuations in the availability of fish because the replenishment and removal balance the sub-populations in the exploited area. For such data, analysis of variance as applied to randomised block design can be reasonably attempted after logarithmic transformation. But when the catches are poor, say, with a mean catch less than 1.5 kg, standard error per unit will increase necessitating experimentation in very large number of blocks which would be impractical as well as uneconomical and analysis of variance approach would not be useful for such data.

Cochran & Cox (1963) and Tippet (1952) have discussed the usefulness of sequential experimentation when the treatments can be applied to a unit in definite time sequence and when the process of measurement is very rapid so that the yield or response on any unit is known before the experimenter treats the next unit in the time sequence. It can be seen that these conditions are fully satisfied for fishing experiments. The sequential experimentation has also the advantage that the experimenter can stop the experiment and examine the accumulated results before deciding whether to continue the experiment or not.

The author is grateful to Dr. C. C. Panduranga Rao, Director, Dr. P. N. Kaul and Shri K. Krishna Rao, all of Central Institute of Fisheries Technology for encouragement, to Dr. K. Alagaraja, Scientist, Central Marine Fisheries Research Institute, Cochin for critically going through the manuscript and suggesting improvements and to Shri H. Krishna Iyer for helpful comments.

References

Cochran, W. G. & Cox, G. M. (1963) *Experimental Design.* John Wiley & Sons, New York, 611 p

May, J. M. (1952) *Biometrika* **39,** 192

Kempthorne, O. (1967) *The Design and Analysis of Experiments.* Wiley Eastern University Edition. Wiley Eastern Pvt. Ltd., New Delhi, 628 p

Panse, V. G. & Sukhatme, P. V. (1957) *Statistical Methods for Agricultural Workers,* Indian Council of Agricultural Research, New Delhi, 361 p

Snedecor, G. W. (1961) *Statistical Methods.* The Iowa State College Press, Ames, Iowa U. S. A., 534 p

Tippet, L. H. C. (1952) *Technological Application of Statistics.* John Wiley & Sons, Inc., London, 186 p

NOTES

Response of Extract Release Volume to the Variations in pH and Microbial Load During Spoilage of Fish at Refrigeration Temperature

Little work has been done using livestock sewage in fish culture. Present report describes the microbial status and storage property of fishes raised under composite fish culture reared in livestock sewage fed pond.

During low temperature storage, microbial growth occurs resulting in physico-chemical changes and ultimate spoilage. The phenomenon of extract release volume (ERV) has been reported as a rapid test for detecting incipient spoilage of meat and shrimp (Jay & Kontou, 1964; Shelef & Jay, 1971). How this phenomenon responds to the change in microbial growth and pH of fishes during spoilage at refrigeration temperature is reported.

Fishes were obtained from composite fish culture pond of the institute. They were brought to the point of sale in gunny bags from where rohu fishes of 1 to 1.5 kg were collected and refrigerated for 10 days. Fresh fishes were analysed for microbial load, pH and ERV on 1st, 4th, 7th and 10th days. Measured area of skin surface (Jay, 1970) was swabbed using sterile template under aseptic precautions and the swab placed in 10 ml sterile diluent of 0.1 % peptone water (IS: 5887-1976). It was agitated and mixed well to give 10^{-1} dilution. This was utilised to prepare further serial ten fold dilutions. Pour plates in quadruplicate were prepared from each of the consecutive three dilutions using standard plate count agar (IS: 5402–1969). Two plates of each dilution were incubated at 37°C for 24h to obtain total mesophilic count. Remaining plates were incubated at 5°C for 5 to 7 days for psychrophilic count. Colonies were counted with an electronic colony counter and reported as count/cm² of the examined surface. Microbial counts reported and discussed in this note are in logarithmic units.

Shelef (1974) was followed for determining ERV with following modifications. 20 g muscle tissue was scrapped from the region behind head. It was homogenised with glass distilled water for one min in a meat blender, filtered through Whatman filter paper no. 1 of 16 cm² size. The volume of extract released during the first 15 min was reported as ERV in ml (Murthy & Bachhil, 1980). pH was recorded with single electrode pH meter by directly inserting the pointed electrode into the muscle tissue.

Anterior half was utilized for ERV and pH and the posterior half for swabbing the skin surface for microbial estimations.

The range and mean values of microbial counts, pH and ERV are presented in Table 1. On an average, mesophilic aerobes

Table 1. *Changes in ERV, pH and microbial counts during refrigeration storage of whole fish*

	1st day		4th day		7th day		10th day	
	R	A	R	A	R	A	R	A
pH	6.40– 6.50	6.46	6.30– 6.40	6.36	6.20– 6.60	6.46	6.60– 6.80	6.72
ERV	25.00–45.00	34.10	17.50– 26.0	21.56	12.0– 18.0	14.65	5.00– 8.50	7.40
Mesophiles	4.83– 6.20	5.34	4.99– 6.93	5.73	5.82– 7.82	6.86	7.00– 8.25	7.76
Psychrophiles	3.78– 5.77	4.48	4.50– 5.55	4.79	4.94– 6.88	5.98	7.00– 8.80	7.45

R = Range, A = Average observation from five fishes for each parameter

were observed to be more than the psychrophiles. This can be attributed to the warmer climate. Shewan (1961) mentioned that the marine fishes show microbial load upto 7.0/cm² of the skin. In warmer seas larger number of these mesophiles are to be expected. The observed higher limit in the present study is less than that of marine fishes. Nair *et al.*, (1971) reported microbial load of 4.14/cm² from fresh water fishes. Skin surface has been stated to harbour heavy bacterial load ranging from 2 log to 5 logs/cm² (Nair & Lahiry, 1968). The microbial load of fishes raised under present system utilizing livestock sewage did not reveal counts higher than the general pattern (Nair *et. al.* 1971).

Increase in microbial numbers were observed both in mesophiles and psychrophilic groups during refrigerated storage at 8°C. Increase in counts upto 4th day is slow, but it is comparatively rapid thereafter (Fig. 1). On 7th day the level of increase was recorded to be almost the same for both the groups. Though the initial psychrophilic count was less than the mesophilic, it almost equalled on the 10th day. Obviously, this is because of the storage temperature. Organoleptically fishes were acceptable on 4th day, but exhibited signs of spoilage on 7th day. Considerable bacterial multiplication did not occur during first four days, probably due to the low pH of 6.3 to 6.4 (Fig. 1). Low pH during rigour is unfavourable to bacteria which explains the less increase in counts. The rigour pH values have been reported in the range of 6.2 to 6.5 (Amlacher, 1961). Nair & Lahiry (1968) mentioned that the growth of organisms responsible for spoilage is effectively checked even at this level. Fig. 1 shows that the pH and microbial counts started rising after 4th day reaching 6.72 and 7.76 on 10th day respectively and the fishes exhibited clear cut spoilage. Nair & Lahiry (1968) observed that the bacterial spoilage produces more undesirable changes in the flavour, odour and appearance in fishes, though oxidative rancidity may precede bacterial deterioration in fatty fishes.

Fig. 1 explains the response of ERV to microbial counts and pH of fishes stored at 8°C. They exhibited symptoms of spoilage in six days. As the pH and microbial

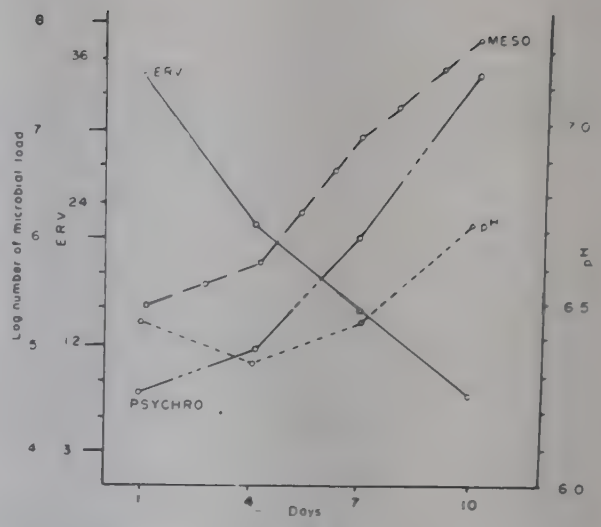


Fig. 1. Response of ERV to changes in pH and microbial load of fishes during spoilage at 8°C

counts increased, ERV decreased. On an average, it reduced to 14.6 on 7th day and at clear spoilage, it came down to 7.4 (Table 1). Raw meat of good organoleptic quality releases large volumes of extract while beef of poor microbial quality releases smaller volumes or none (Jay, 1970). Murthy & Bachhil (1980) also reported reduction in ERV of spoiling pork at refrigeration temperature. Jay (1970) further mentioned that when meats undergo spoilage, ERV is decreased rather than increased. Ingram & Dainty (1971) observed that the physicochemical basis of increase in hydration during storage is not properly understood, but it is postulated that the spoilage flora damage the sarcolemma membrane which controls the permeability of muscle fibre. Murthy & Bachhil (1980) considered pH as an important factor for increase in meat hydration besides alteration in metal ion balance and production of amino sugar complexes by spoilage flora. An interesting phenomenon revealed by ERV is that break down of primary proteins, alteast complete break down, does not occur in meats (Jay, 1970). Lerke *et al.* (1963) showed raw fish press juice to display all apparent fish spoilage as may be determined by whole fish. This indicates a general lack of attack upon insoluble proteins by fish spoilage flora since these proteins are absent from filtered press juice.

Thanks are due to Director, Indian Veterinary Research Institute for providing necessary facilities.

References

Amlacher, E. (1961) in *Fish As Food* (Georg Borgstrom Ed.) Vol. I, p. 385, Academic Press, New York

Ingram, M. & Dainty, R. H. (1971) *J. Appl. Microbiol.* **34,** 21

IS: 5402 (1969) *Indian Standards on Food Microbiology*, Indian Standard Institution, New Delhi

IS: 5887 (1976) *Indian Standards on Food Microbiology,* Indian Standard Institution, New Delhi

Jay, J. M. (1970) *Modern Food Microbiology,* Van Nostrand & Reinhold Co., New York

Jay, J. M. & Kontou, K. S. (1964) *Appl. Microbiol.* **12,** 378

Lerke, P., Adams, R. & Farber, L. (1963) *Appl. Microbiol.* **13,** 625

Murthy, T. R. K. & Bachhil, V. N. (1980) *J. Fd Sci Technol,* **8,** 53

Nair, R. B. & Lahiry, N. L. (1968) *J. Fd Sci. Technol.* **5,** 107

Nair, R. B., Tharamani, P. K. & Lahiry, N. L. (1971) *J. Fd Sci. Technol.* **8,** 53

Shelef, L. A. (1974) *J. Appl. Bact.* **37,** 531

Shelef, L. A. & Jay, J. M. (1971) *J. Fd Sci.* **36,** 994

Shewan, J. M. (1961) in *Fish As Food* (Georg Borgstrom, Ed.) Vol. 1, p. 487 Academic Press, New York

Division of Livestock Products Technology,
Indian Veterinary Research Institute,
Izatnagar, U.P.

V. N. BACHHIL

Improving the Acceptability of Canned Mackerel Tuna *(Euthynnus affinis)*

White and light meat tuna, namely, *Thunnus albacares* (yellow fin), *Thunnus alalunga, Thunnus thynnus* (blue fin), *Thunnus tonggol* (northern blue fin), *Katsuwonus pelamis* (oceanic skipjack) are commonly used for canning. Black meat or dark meat varieties such as *Auxis thazard* (frigate mackerel) and *Euthynnus affinis* (mackerel tuna) are considered unsuitable for canning because of the dark colour of meat, unpleasant flavour and poor yield. Majority of tuna landings in India is contributed by *Euthynnus affinis* which, being the dark meat variety is not in demand for fresh consumption nor is used for processing.

Canned tuna is very much in demand in all the overseas markets. A variety of canned fish products including white and light meat tuna canned with vegetables and spices to improve the flavour and appearance are popular in several countries. It has been noted that if a better flavour and appearance to be imparted, even black meat varieties of tuna can find acceptance in India and abroad. This will ensure economic utilization of the hitherto underutilised black meat tuna resources and will also help in the diversification of the seafood canning industry necessary for making use of the idle capacity. The method of improving the colour and flavour of canned mackerel tuna and the modification in the canning process adopted are reported in this communication.

Tuna caught in gill nets were kept in ice until used for canning. Dry red chilly *(Capsicum annum)* was used to impart colour and flavour to the canned product. An easy and cheap process was employed to extract the colour of red chilly. After removing seeds and stalk the dry chilly was powdered well and gently warmed after suspending in vegetable oil used as canning medium and then decanted. This was continued until most of the colour was extracted and the combined oil extracts were filtered through fine cloth to remove solid particles and the concentrate thus prepared was suitably diluted with fresh oil.

The method of canning adopted was essentially that of Madhavan & Balachandran (1971) with slight modification. It was found difficult to maintain the drip water in oil at not more than 5% (v/v), unless extreme care is taken in draining the brine from the pieces after dipping. Therefore instead of dipping in the brine, 2% salt was added to the meat in can. Processed cans were kept at room temperature for a sufficient length of time to permit equitable distribution of salt and flavour. Simultaneously cans were prepared from the same lot of tuna processed under identical conditions with plain oil as the filling medium.

On opening the can, with the contents in tact, it was found that tuna packed in spiced oil had a better appearance as the brownish colour of the fish meat was masked by the pigments of chilly, whereas in the other pack the brownish colour of the meat was visible through the oil. However, the meat did not absorb any colour from the oil and on draining the oil, the meat had similar colour in either cases. Taste, flavour and odour were better in the meat packed in spiced oil.

Both products were stored at room temperature for a period of one year and examined periodically for the quality as well as the soundness of the can interior. It was observed after 12 months that the contents and can interior remained intact without any perceptible sign of deterioration. Neither the pigments nor the essential oils in chilly did affect the can lacquer in any way. The storage period increased the absorption of

the spicy flavour by the meat and this improved the taste and flavour considerably. After one year, fish packed in spiced oil showed marked improvement in flavour and taste over the one packed in plain oil. By this time the meat had taken up a slight pungency from the essential oils of chilly and this resulted in improving the taste to a very great extent.

Reference

Madhavan, P. & Balachandran, K. K. (1971) *Fish. Technol.* **8**, 1

K. K. BALACHANDRAN
P. K. VIJAYAN
&
JOSE JOSEPH

Central Institute of Fisheries Technology, Cochin–682 029

LETTER TO THE EDITOR

Dear Sir,

I would like to draw your attention to the technical paper entitled "Standing Stock of Three Species of Demersal Fishes from South–West Coast of India" by Mathew M. Maliel *et al.* which appeared in volume 17, No. 2, 1980, pp. 87–91, in your esteemed journal. The authors assessed the standing stock of *Nemipterus japonicus, Saurida tumbil* and *Grammoplites scaber* spread over 850 sq.m along the west coast, from Suratkal in north to Someshwar in south upto 50 m depth. For the assessment, the above area is divided into 12 fixed sampling stations, 3 each at 20, 30, 40 and 50 metres depth. The period of investigations was from March, 1976 to March, 1977 excluding the monsoon period. It is stated that sampling was taken at fortnightly intervals and assessment is based on 96 hauls. This clearly indicates an average of 8 hauls/ station were made during a span of 12 months. I would like to know how the sampling was done from one vessel with 6 hauls per voyage on a fortnightly basis covering all the twelve stations on a statistical basis. The authors have failed to give how they programmed the fishing along the stations and how frequently they did so in each station. It is also not clear what is the time lapse from station SM1 to station SK4 or station SK1 to SM4. Since the experiment covers a full year period the climatic and oceanographic conditions change considerably along with the migratory and feeding habits of fish. Moreover if there is considerable time lapse between stations has it been statistically proved that the fishing conditions were the same. The authors have also mentioned that they have followed the technique of Mr. Alverson. Has the technique not taken into account of the changing conditions and variations. In such conditions of incomplete the insufficient programme and data collection on a systematic scientific and statistical order, will the conclusions arrived at regarding the standing stock of the species give a correct appraisal of the standing stock? So I invite the authors to kindly enlighten me and the readers of the Journal about the doubts.

Central Institute of
Fisheries Technology,
Cochin-682 029

P. A. PANICKER

Dear Sir,

In reply to Shri P. A. Panicker's queries concerning the sampling technique and validity of the conclusions of our paper entitled "Standing Stock of Three Species of Demersal Fishes from South-west Coast of India", *Fish. Technol.* (1980) 17, 87–91, we would appreciate it if you would publish this letter in its entirety.

Throughout the period of investigation samples were taken each fortnight at all the 12 stations, thereby collecting a total of 192 samples. The 96 hauls listed in Table 1 represent monthly values obtained by averaging two fortnightly hauls. As described in our paper, stations along specific isobaths were sampled between 0700 and 1500 hours on the same day. Choice of the isobath to be sampled and the day of sampling were randomly selected within the fortnight. Thus the time lapse between sampling at stations SM1 and SK4 or SK1 and SM4 could have been as small as 24 hours or as large as 14 days. This random selection of sampling day and site eliminates errors inherent to systematic sampling. Again, as described in our paper, the direction of trawling along an isobath was reversed each fortnight to nullify the possible effect of diurnal variations on the sample collected. Thus it may be deduced from the description of the methodology and Table 1 that the assessment of the standing stock was based on 16 samples per station during this study.

It is well known that hydrographic features of waterbodies, the biological parameters of specific fisheries and the interactions of the elements within communities could singly or jointly influence the biomass of fish present at any time and place. Even given extensive biological and hydrographic information, it is often impossible to isolate those particular factors which govern the distribution and relative abundance of the species being studied. In designing the methodology for the present study, possible fluctuations in the spatial and temporal organization of the three populations were taken into consideration. Estimates based on data collected within one short time period could well be highly unreliable due to the variations in time and space as described. The estimates presented in our paper are based on an extensive sampling program spread over one year for the purpose of minimizing the effect of possible seasonal variations in fish number on the estimation of standing stocks. We did not attempt to statistically prove that fishing conditions were the same, as queried by Shri Panicker; rather we used statistics to estimate the standing stock of three species given that seasonal fluctuations may occur. The number of sampling stations and the frequency of sampling were chosen to reduce errors due to this dynamic nature of populations.

In the light of what is stated above, we feel that the statement of Shri Panicker that "in such conditions of incomplete, insufficient programme and data collection on a systematic, scientific and statistical order will the conclusions arrived at regarding the standing stock of the species give a correct appraisal of the standing stock?" is unjustified and uncalled for. Shri Panicker seems to be thinking of statistical models developed based on available data from different sources, and probably feels that the present work has not looked into all variables to arrive at a better conclusion. We are inclined to believe that a statistical model which is simply an elaborate mathematical summary of a text book does not tell us much more than we already know. There is of course no inherent evil in attempting to simplify what we know or suspect of nature, so that we can handle the almost infinite variations of events in the natural world, and perhaps to arrive at some modest hope of prediction.

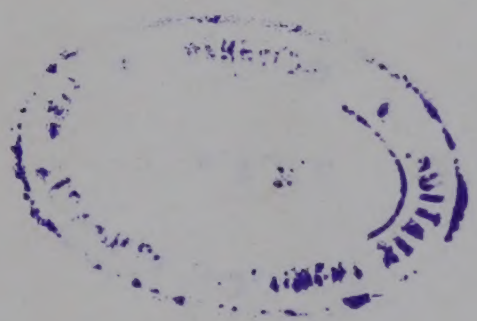
As fish population dynamics are renowned for their complexity, it is fundamental that irregularities in the sampling techniques are eliminated or at least minimized. Workers associated with survey techniques and stock assessment would be familiar with both

theoretical and practical problems inherent to this discipline and would recognize the need for standardizing their techniques. However, the value of surveys should not be underestimated. Surveys, such as the one presented in our paper, which use standardized techniques to minimize problems inherent in sampling of fish populations, provide reliable estimates of standing stock as the baseline data for further research.

University of Agricultural
Sciences, College of Fisheries,
Mangalore-575 002

MATHEW M. MALIEL
P. K. SALIAN
N. R. MENON

FISH TECHNOLOG. EXPERIMENT STATION
C.F.T.R.I.
MANGALORE.



Regd. No. 7720/64